

**A STUDY OF THE MORPHOLOGY OF THE
VERMIFORM APPENDIX**

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for the award of**

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CERTIFICATE

This is to certify that the dissertation entitled “**A STUDY OF THE MORPHOLOGY OF THE VERMIFORM APPENDIX**” is bonafide work done by **Dr.R.KALAMUTHARASI**, under the guidance and supervision of **Dr.M.SOBANA D.G.O., M.S.**, (Anatomy), Associate Professor, in the Institute of Anatomy, Madurai Medical College, Madurai during the period of her postgraduate study of M.D Anatomy from 2014-2017.

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DECLARATION

I, **Dr.R.KALAMUTHARASI** solemnly declare that the dissertation titled **“A STUDY OF MORPHOLOGY OF THE VERMIFORM APPENDIX”** has been done by me at Institute of Anatomy, Madurai Medical College, Madurai. I also declare that this bonafide work or part of this work was not submitted by me or any other for any award, degree, diploma to any other university board either in India or abroad.

This is submitted to The Tamil Nadu Dr. M.G.R. Medical University, Chennai in partial fulfillment of the rules and regulations for the award M.D. Degree (ANATOMY BRANCH) to be held in April 2017.

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INTRODUCTION

INTRODUCTION

The Vermiform Appendix has been considered as a vestige of evolution with a tendency to become diseased and as a bane to humanity. This “worm-like” structure can now be argued to be very useful in reconstructive surgical techniques and make the appendix a useful organ.

Appendix is present only in humans and certain anthropoid apes. In man, it develops through evolution from old world monkeys. It is found in few marsupials and rodents. It is absent in fishes, amphibians, reptiles, birds and most mammals.¹ In herbivores the caecum and appendix are larger in size and an important site of cellulose digestion by symbiotic bacteria.

The vermiform appendix (VA) is normally located in the right lower quadrant of the abdomen. Its position in the abdomen corresponds to a point on the surface of the anterior abdominal wall known as Mc Burney’s point. The position of base of appendix is constant lying 2cm below ileo-caecal valve.² During embryonic development its position in the abdomen is not constant. It is found at different locations in the abdominal cavity depending upon the stage of development and rotation of gut.³

The vermiform appendix belongs to Mucosa Associated Lymphatic Tissue (MALT) and also called as Abdominal Tonsil. The lumen is irregularly narrowed by submucosal lymphoid tissue. It may be widely patent in early childhood but often partially or wholly obliterated in adults. Its lumen may be occluded by faecolith, foreign body or worms.⁴

Even though the vermiform appendix is considered to be a vestigial organ; its importance in surgery results only from its propensity for inflammation, which results in the clinical syndrome known as “Acute Appendicitis”. It is the most common cause of an acute abdomen in young adults all over world⁵ Worldwide, perforated appendicitis is the leading general cause of death. Obstruction of lumen is found to be major cause and may be caused by fecolith, foreign body, parasites or neoplasm. Obstruction leads to bacterial overgrowth and continued secretion of mucus leads to intraluminal distension. Subsequent impairment of lymphatic and venous drainage produce mucosal ischaemia,⁶ Diagnosis is complicated in obese, elderly patients and in pregnancy. Presentation of symptoms vary in certain positions like diarrhea and frequency of micturition in pelvic, retching in post-ileal, silent appendix in retro- caecal etc.

Vermiform appendix has greater clinical significance as it is involved in many diseases such as appendicitis, carcinoma and diverticulitis. But appendicitis is rare in children below two years of age due to its anatomical characteristics and its relation with caecum. The immunological importance of appendix removal as a precautionary method to prevent future possibility of appendicitis.⁷

Appendiceal variation is an extremely rare congenital anomaly seen in 0.004-0.009%. It may be associated with congenital anomalies like agenesis, duplication, triplication, horseshoe appendix etc. It may be associated with meckel’s diverticulum. Also Appendix duplication was first classified by cave⁸

in 1936 and modified in 1963 by wallbridge⁹, again modified by Biermann¹⁰ in 1933. This system classified into three types A, B&C.

In 1980 Mitrofanoff¹¹ described the use of isolated appendix as an ideal conduit. Since then various methods to create an ideal continence mechanism using appendix was reported. The length of the appendix must be 9-10 cm and it should be dilatable up to 16-18 F.

The vermiform appendix is an epithelialized, vascularized, isoperistaltic conduit. It is more physiological and anatomical. It has its own mesoappendix and can be isolated easily. If the appendix is of adequate length and mean caliber it will be useful in biliary tract re-constructive surgeries.¹²

In biliary atresia, and choledochal cyst appendix was used as a biliary conduit in children by doing appendico duodenostomy^{12,13}

Appendix used as a ureteral conduit in urology and long term patency and function has been documented¹⁴ In neurogenic bladder, Appendicovesicostomy done with appendiceal conduit.¹⁵

In Idiopathic chronic constipation of paediatric population, Malone Antigrade Continence Enema procedure (MACE) done with long, patent appendix using mitronoff principle.¹⁶

Following laryngectomy, appendix was used for creation of a tracheo-oesophageal fistula- a new method of voice reconstruction.¹⁷

AIM OF THE STUDY

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To study the morphology of the vermiform appendix in 50 cases during abdominal surgeries.

**REVIEW OF
LITERATURE**

REVIEW OF LITERATURE

In Egyptian civilization 3000 BC while doing mummification process abdominal viscera were taken and placed in Coptic jars. From the inscriptions of jars, the appendix was probably noted first as “worm of the intestines”.¹⁸

Berengario De Capri¹⁹ – 1521 Published drawings about the appendix (Deaver) **Andrew Vesalius**²⁰ (1543) illustrated about the vermiform appendix in his book “DE HUMAN CORPORIS FABRICA. ‘**Jean Fernel**²¹ – 1544 first person described about appendiceal disease and published paper

In 1711, **Lorenz Heister**,²² professor of surgery at Helmstedt recognized that appendix might be the site of acute primary inflammation.

In 1736, **Claudius Amyand**²³ a surgeon at St. George’s hospital in London, done first appendisectomy in 11 year old boy with scrotal hernia. He found a perforated appendix with in hernia sac.

Leonardo Da Vinci²⁴ (1742) was the first person to describe the appendix in his drawings. He called it “Erecchio” literally means ear to denote the auricular appendage of caecum.

Fergus²³ in Canada performed the first elective appendisectomy in 1883.

Reginald Fitz²⁴ 1886 a professor of pathological anatomy at Harvard was credited with coining the term “Appendicitis” He identified the appendix as the primary cause of right lower quadrant inflammation.

The greatest contributor was **Charles Mc Burney**²⁵. In 1889 he described the Mc Burney’s point as maximum tenderness when examined with

the fingertips in adults one half to two inches inside the right anterior spines process of the ilium on a line drawn to the umbilicus.

Fredric Treves²⁶ (1890) advocated conservative management of acute appendicitis by appendisectomy after infection subsided.

Berry RJA²⁷ (1895) studied the length of appendix in 100 cadavers and the findings are the average length was 8.3cms and ranged between 3.1 to 13.3cm and the average diameter of appendix was 0.6cm at the base.

Fawcett²⁸ (1895) reported long vermiform appendix.

In 1902 **Albert oschner**²⁹ surgeon from Chicago recommended a conservative approach to patients with generalized peritonitis after appendicular perforation to allow surgical intervention at later date.

Hedinger³⁰ (1904) reported an appendicular diverticulum. **Kelly** and **Hordon**³¹ (1905) described appendicular arteries in detail. In 66% of appendixes the distal $\frac{3}{4}$ was supplied by main AA and proximal $\frac{1}{4}$ was supplied by accessory AA.

Deaver³² (1913) stated that the shortest appendix was 1cm in length and the longest appendix was 23cm in length and the average diameter was 0.6cm in his study of morphology of appendix in 200 cadavers.

Gladstone³³ (1915) reported agenesis of appendix and **schrup**³⁴ (1915) found a left – sided appendix.

Macphil (1917)³⁵ studied the morphology of appendix in 220 cases and stated that the average length was 9.9cms, the average diameter was 6mm at its base and it is longer in males than females.

Gladstone and Wakeley (1923)³⁶ studied the various positions of appendix in 3000 cases. Retrocaecal and Retro colic positions 65%, Pelvic 31%, Subcaecal 2.26%, Preileal 1 %, Post ileal 0.5% and Ectopic 0.05%.

Retrocaecal and Retrocolic was the most common site. The mesoappendix was quite short in retrocolic position. There might be a short mesentery which holds the appendix in contact with the posterior surface of the caecum and ascending colon.

Donald Collins C (1931)³⁷ analyzed the morphology of appendix in 4680 specimens and stated that the average length of appendix was 8.21cm. Position of appendix was pelvic 50%, retrocaecal 21.5%, subcaecal 1.24%, preileal 1%, post-ileal 0.71% and ectopic 1%.

Wakeley³⁸ (1933) after analyzing 10,000 cases found that retrocaecal (65%) was the commonest position followed by pelvic (31%) subcaecal (2.26%), preileal (1%) and postileal (0.4%). There might be short mesentery which holds appendix in contact with the posterior surface of caecum and ascending colon.

Waugh³⁹ (1941) reported a case of duplication of vermiform appendix and cavities of both appendix communicating with each other.

Shah and shah⁴⁰ (1946) described the seven type of arterial patterns. Singleton and King (1951)⁴¹ reported a case of persistent vitello intestinal duct continuous with vermiform appendix.

Douglas (1954)⁴² observed a rare case of congenital absence of entire right colon along with caecum and appendix.

Maisol⁴³ (1960) analyzed the various positions in different age groups and found that anomalies were common in childhood.

T Solanke⁴⁴ (1970) analyzed the morphology of appendix in Nigerians. He reported the pelvic position as commonest and relative rarity of appendicitis in Africans due to the dual blood supply and arterial anastomosis in mesoappendix.

Grosfeld et al (1971)⁷ was the first man to use an appendiceal graft in mongrel dogs.

Weinberg RW (1976)¹⁴ used appendix as a ureteral conduit and long term patency and function documented.

Katezarski M, (1979)⁴⁵ studied the morphology and arterial pattern of vermiform appendix in 103 cadavers in Zambia. Position of the appendix was pelvic 43.6%, retrocaecal 20.3%, retro colic 20% and other positions 16%. The average length in male was 12cm and in female was 11.9cm. Dual blood supply found in 39.8%. Pelvic position was predominant and dual blood supply would be cause for rarity of appendicitis in Africans.

Bax and Pense⁴⁶ (1980) observed a case of perforated appendix in the neonatal period.

In 1980, ¹¹ Mitrofanoff described the use of the appendix as a continent vesicostomy. He created a channel for a catheter between the abdominal wall and urinary bladder. Mitrofanoff's principle was used in Mitrofanoff procedure, Malone antegrade continence enema and Monti procedure.

Abramson DJ et al (1983)⁴⁷ reported a case of aberrant position of appendix located inside the posterior wall of caecum, beneath of serosa. He revealed a slightly palpable, elliptic thickening, 8cm in length and had the appearance of “Peeled seedless grape” devoid of serosa coat.

Ajmani ML and **Ajmani K** (1983)⁴⁸ studied the length, position and arterial pattern of appendix in 100 Indians in Uttar Pradesh state. Position of the Appendix was retrocaecal 68%, pelvic 20%, postileal 10%, preileal 1% and Others 1%. The average length in male 9.5cms and the average length in female 8.7cms. Double appendicular artery found in 39%. Postileal position in Indians would be associated with complications like intestinal obstruction.

Gupta DK, Rohatgi et al (1989)⁴⁹ used appendix in biliary arteria. Post-operative cholangitis was the main problem that the surgeon had to face in these patients. He stated that it might be due to the role played by the presence of lymphoid follicles in the wall of the appendix.

Karim OM,⁵⁰ (1991) made a study in 50 cases regarding the position occupied by appendix in pelvic region 59%, umbilical region 15% inguinal region 11% and right iliac region 20%. Accurate knowledge of position of the base of appendix might influence the level of incision for appendisectomy.

Ramsten WH, (1993)⁵¹ analyzed the relation between base of appendix and Mc Burney's point and the observations were in 75% of cases the base of appendix was medial to and within 5 cm of Mc Burney's point. In 20% of cases, the base situated medial to and within 10cm of Mc Burney's point. In 5% of cases, the base of appendix situated lateral to Mc Burney's point.

Lobert⁵² (1994) used appendix mucosa for urethroplasty. **Michael W.L.Gauderer**,⁵³ (1996) performed cholecysto appendicostomy in a child with alagille syndrome. They had done a partial biliary diversion using the appendix vermiform as a Conduit between the gall-bladder and the abdominal wall skin. The appendix has a lumen closer to that of the biliary tree, does not accumulate significant amount of bile and provides a smaller stoma.

Val Bernal Jf,⁵⁴ et al (1996) reported a case of torsion of appendix in 6 years old boy with abnormally long appendix 13.5cm and pelvic in position. They concluded that abnormally long appendix occupying pelvic position would be the precipitating factor for torsion.

Yasaka okado,⁵⁵ (1997) done a urinary reconstruction using appendix as a urinary and catheterizable conduit in 12 patients with pelvic malignancies. The appendix was used as a conduit between the Ureter and the skin with modified mainz pouch (or) continent vesicostomy. Complete continence and easy catheterization can be obtained with appendix conduit.

N Simforoosh,⁵⁶ (1998) used an unaltered insitu appendiceal conduit for continent urinary diversion in 19 patients. This unaltered insitu appendix techniques is timesaving, safe, effective and comparable than other methods.

Bakheit MA,⁵⁷ (1999) studied the anomalies of the appendix in Saudi Arabians. Position of the appendix was retrocaecal in 58.3%, pelvic 1.7%, post ileal 10%, pre – ileal 2% and Other rare positions 8%.

Rebhandl,⁵⁸ (1999) employed appendix conduit for biliary diversion (Cholecysto appendicostomy) in a child with progressive familial Intrahepatic cholestasis. Modified mitrafanoff's procedure may be applied for drainage of gall bladder in byler disease. The appendix provides an epithelialized, vascularized, isoperistaltic conduit with a smaller diameter than the jejunum and can be isolated more easily than jejunum.

Dubois (2001)⁵⁹ used the caeco-appendicular conduit for continent urinary diversion.

Retten Bachar T⁶⁰, (2001) studied the outer diameter of appendix at the base to exclude appendicitis in 278 patients and reported as outer diameter of more than 6mm was the indicator of acute appendicitis with high sensitivity.

Kajbafzadeh AM⁶¹, (2001) done a simultaneous malone ante grade continent Enema (MACE) and Mitrafanoff principle of continent urinary diversion in 40 patients about 4-22 years old. All patients had an anti-reflux Mitrafanoff channel constructed using distal part at the appendix with its divided mesothelium and with length of 9cm or more. It proved invaluable for the treatment of children with urinary and fetal incontinence and lower incidence of stomal complications.

V Narayn singh⁶² (2002) reported a marked variation in the position of base in relation to Mc Burney's point, is clinically significant. The base of the appendix was 67% cephalic, 32% caudal and only 1% on it.

Amar A shah and Aniruth V shah (2002)¹² presented their experience of treated 3 children with extrahepatic biliary atresia by using appendix as biliary conduit. The operative procedure was simple and less time consuming and achieved an anatomic reconstruction which is close to normal.

Delic J⁶³, (2002) studied the variations in the position and point of origin of appendix in Croatia about 500 cadavers. In position of the appendix, pelvic variety was the most common.

Ferri E⁶⁴, (2002) analyzed the diameter of appendix in 200 cases and the average diameter of appendix was 6.5mm. Diameter variability along the length of same appendix seen in 5% and the wall thickness of appendix was 2.5mm.

Golalipour MJ⁶⁵, (2003) studied the position, length and extent of mesoappendix in 117 Iraian Cadavers. The average length of appendix in male was 6.61cms and the average length of appendix in female was 6.06 cms. Position of the Appendix was pelvic 33%, retrocaecal 32.4%,retrocolic 32.4%, preileal 18%,subcaecal 12.8% and postileal 2.6%. Meso appendix extends upto the tip in 34.2% and failed to reach tip in 65.8%

Cave⁸ and Wall bridge (2004)⁹ studied the duplication of appendix and classified into three types

- Type I - Partial duplication of appendix on a single caecum.
- Type II - Single caecum with two completely separated appendices.
- Type III - Two caecum with separate appendices.

Shah AA, Shah AV (2005)¹³ - used appendix as a biliary conduit for choledochal cyst in six children. After mobilization the appendix on its vascular pedicle, non refluxing, tunneled anastomosis was made with the 2nd part of the duodenum and appendix. Postoperative cholangitis was absent in the 2 years follow-up.

H.C Chen, (2006)¹⁷ reported a new method of voice reconstruction with vermiform appendix. Three patients with an average age of 53 years underwent the procedure of free transfer of appendix for creation of trachea- oesophageal fistula. The results of this study indicated that this method had a potential role in voice reconstruction but required more experience and refinement.

Cleg lamptey⁶⁶ 2006 conducted a retrospective study to test hypothesis the retrocaecal appendix is less prone to inflammation. The retrocaecal position was most prevalent in both males and females in autopsy as well as in inflamed appendices. Comparing with non retrocaecal position formerly was prone to inflammation (P<0.001).

Ewen A Griffith⁶⁷, (2006) presented a case report of bifid vermiform appendix in 23 year old man. One appendix was grossly gangrenous and lacked a meso appendix, where the other had a mesoappendix appeared normal.

Y.K.Sarin⁶⁸, (2006) presented a case of torsion of appendix in a 9 years old boy. At operation, 8cm long retrocaecal appendix was revealed that had torted 270 clockwise. It may be associated with long appendix and pelvic position of the appendix.

Leonid uriev⁶⁹ (2006) presented a first case of triple barreled type of appendiceal triplication. Appendix was 5.5cm in length and 1.6cm in diameter. Cutsection showed three tiny lumina extends from base to tip.

Atul Thakre⁷⁰, (2008) reported Robot- Assisted Mitrofanoff and Malone Antigrade continence Enema reconstruction with divided appendix in Paediatric case. The appendix stump with caecum is an ideal channel for simultaneous with appendix of 9cm or more and branching mesoappendix.

Zetina mejfa CA⁷¹ (2009) reported a absence of caecal appendix in 45 years old male. After celioscopy, it was reported as type 4 collins appendiceal agenesis along mesenteric adenitis.

Uttam kumar Paul⁷², (2009) done a postmortem study in 60 cadavers about the position of vermiform appendix. Retrocaecal position 65% was highest followed by pelvic and postileal. Subcaecal and preileal were not found. To determine the positions of vermiform appendix sonological studies are also recommended.

Rehman MM⁷³ (2009) studied extent of mesoappendix in Bangladeshi people and the variation in the anatomical position of appendix. Pelvic position of the vermiform appendix were found to be common in both sexes. The two – thirds and whole extension of the mesoappendix were common in males and pelvic variety commonly seen in them. The extent of mesoappendix to two – thirds length of vermiform appendix was 45% and more common in pelvic variety. The 2/3 extension is more than half and whole extension of

mesoappendix. Extension of mesoappendix is responsible for vascularization of vermiform appendix and severity during inflammation.

A Ninos⁷⁴ (2010) found a horse shoe appendix in a female patient with nonspecific abdominal pain and incidental finding was non-hodgkins lymphoma.

Calota F⁷⁵ (2010) reported a horse shoe appendix about 13cm long in a patient with bowel occlusion. These anomalies are thought to result from the persistence of transient embryologic second caecal appendix.

Seyed Mohammed vahid Hosseini⁷⁶, (2010) used appendiceal conduit in the management of biliary atresia associated with bowel atresia in a 2 years old boy. Appendico – duodenostomy was performed for biliary atresia as a second procedure and it prevented the reflux cholangitis and saved the entire small bowel.

Michael rink⁷⁷, (2010) – recommended catheterizable pouches for urinary diversion in bladder cancer patients especially with carcinoma - in - situ and female patients using appendix stoma. Satisfactory continence rate more than 90% are reported for most techniques and quality of life was comparable with orthotopic continent diversion.

Heidi chua¹⁶ (2011) states that Malone Ante grade continence enema had been used in paediatric population with idiopathic chronic constipation. MACE done open (or) laproscopically, the procedure is simple with the appendix conduit.

Shariar ahmadpour⁷⁸, 2011 reported a rare anomaly of subhepatic appendix in a macrosomic infant. Subhepatic appendix also associated with other anomalies like retroperitoneal ileum, intraperitoneal ascending colon and maldescendant caecum.

Geethanjali HT⁷⁹, 2011 studied the variation in the position, length of appendix and extent of mesoappendix in 52 cadavers. The incidence of pelvic position was the highest 36.54% followed by retrocaecal 33%. The average length in males was 6.47cm and in females was 5.34cm. This difference was statically significant ($P < 0.05$). The Mesoappendix extended up to the tip of appendix in 69.23% and failed to reach tip – 30.77%.

Umesh Kulkarni⁸⁰ (2011) done a study about accessory appendicular arteries. These arterial supply to tip of appendix reduce the possibility of gangrenous appendicitis and provide some immunity against appendicitis.

Ashindoitiang⁸¹ (2012) studied anatomical variation of appendix in patients with acute appendicitis among two major groups, Nigeria. Highest incidence of acute appendicitis seen in 21-30years age group. Retrocaecal position was common in yosubas 51% and both retrocaecal and pelvic was common in Ibos 28%. The average length 11.5cm, about 0.4cm more in males and extent of mesoappendix had no influence.

A Sarcar⁸² (2012) found agenesis of appendix in 60 year old male cadaver. This suggests the possibility that vermiform appendix would ultimately become rudimentary or absent in course of evolution.

Hosmani veeresh⁸³, (2012) studied the arterial supply of vermiform appendix in 52 human specimens. Out of 52 specimens, 12 specimens (23%) showed an abnormal appendicular artery. The appendicular artery originated from inferior division of ileocolic artery in 46.15%, Origin from ileal branch 30.76% and Directly from ileocolic artery 19.23%. Anastomosis of appendicular artery with posterior caecal, ileal and common caecal branches are also seen.

Punitha Sharma⁸⁴, (2012) reported a bifid appendix. One appendix was 2.3cm and second appendix arose 1.8cm from the base of its stump about 6.5cm long with single appendicular artery in the single mesoappendix.

Modified Cave-Wall bridge (2012)⁹ classification:

| Classification of types of appendix duplication | Features |
|--|--|
| A [7] | Single caecum with various degrees of incomplete duplication |
| B1[bird type] [10] | Two appendices symmetrically placed on either side of the ileocecal valve |
| B2[tenia coli type](10) | One appendix arises from the caecum at the usual site, and second appendix branches from the cecum along the lines of the taenia at various distances from the first |
| B3 (3,4) | One appendix arises from the usual site, and the second appendix arises from the hepatic flexura. |
| B4 [3,4] | One appendix arises from the usual site, and the second appendix arises from the splenic flexura |
| C [10] | Double caecum, each with an appendix |
| Horseshoe appendix [6,12,13] | One appendix has two openings into a common cecum |
| D Triple appendix [14,15] | One appendix arises from the cecum at the usual site, and two additional appendixes arises from the colon |

Walsh James M McKiernan MD⁸⁵ (2012), cutaneous continent urinary diversion. Continent urinary diversion is widely accepted by both urologist and patient for urinary reconstruction after cystectomy. Orthotopic urethral anastomotic procedures and continent catheterizable stomal reservoirs should be considered for all patients. Four general techniques have been employed to create a dependable catheterizable Continence Zone including right colon pouches, appendiceal techniques, psuedoappendiceal tubes and ileocaecal valve plication. Appendiceal tunnelling procedures are the simplest of all to perform and remains as attractive and reliable continence mechanism.

Arindom Banerjee⁸⁶, (2012) done a cadaveric study to assess the morphological variations in the anatomy of caecum and appendix. In 24 out of 25 cases, the vermiform appendix was situated in the right iliac fossa and in one case caecum and appendix both lie in sub-hepatic region. Retrocaecal position 68% was the most common followed by pelvic position 8% then promontric position 16%,midinguinal position 4% and ectopic position 4%.The length of appendix was 6.3cm with 2.08SD and the breadth of appendix was 0.78cm with 0.28SD,mesoappendix complete 4 cases and mesoappendix failed to reach tip in 21 cases. Mostly appendix was supplied by appendicular artery, branch of ileocolic arteryand in two specimens, additional supply from the artery of seshachalam, branch of posterior caecal artery.

Tofighi H⁸⁷, (2012) done a cross-sectional study to analyse the anatomical positions of appendix in 400 Iranian cadavers. In that study the position of the appendix was pelvic 55.8%, sub caecal 19%, retro-ileal 12.5%,

retro-caecal 7%,ectopic 4.2% and pre-ileal 1.5%.The mean length of vermiform appendix in male was 91.2mm and in female was 80.3mm.Mesoappendix was complete in 79.5% and incomplete in 20.5%.No association between sex and anatomical position of vermiform appendix but race, geographical regions and nutritional regiment may play role in determining the position of vermiform appendix.

Sabiston (2012)⁶ states that the most common location is retro caecal and then pelvic which was 30%. The length of the appendix varies from 2-20 cm and the average length was 9cm in adults. The tip of the appendix may lie in various locations. The varying location of the tip of the appendix explained the myriad of symptoms that are attributable to the inflamed appendix

Bailey and love's (2013)⁵ has concluded the position of appendix as retro caecal 74%,para caecal 2%,sub caecal 1.5%,pelvic 21%, pre ileal1% and post ileal 0.5%. The average length of the appendix range between 7.5cms to 10 cms.

Siva Nageswara Rao Sundara setty⁸⁸, (2013) studied the morphometric analysis of Human cadaveric caecum and vermiform appendix in Andhra Pradesh, India.The retro caecal position is most common in adults and fetuses.The length of the appendix is more in male adults and fetus than the female adults and fetus. The Average Breadth of the appendix also more in the male adult and fetus than the female adult and fetus.

Reshma Mohammed⁸⁹, (2013) studied the morphological features and morphometric parameters of human fetal vermiform appendix at different gestational ages in aborted human fetuses at ages 17-40 weeks. In their studies, an equal incidence (40%) of sub-hepatic and right iliac fossa and lower incidence (20%) of right lumbar location. Similarly in less than 30 weeks higher incidence of sub-hepatic position and in more than 30 weeks right-iliac fossa position and an equal incidence of right lumbar location. In males higher incidence of sub-hepatic position, in females right iliac fossa and equal between two sexes in right lumbar position. On locating the base of appendix in relation to the wall of caecum, posterior wall had the higher incidence. The percentage incidence of a position medial to McBurney's is nearly two times higher than that of a position lateral to it. Appendicular orifice at Mc Burney's point have higher incidence in females than males. Incidence of direction of tip of appendix pointing downward is more at 47%. Clock wise position of appendix observed at 6 o' clock in 45% the high. Postileal position of the appendix most common with 37%. The length of appendix increased with increase in gestational age. It's more in male than female fetuses. The diameter of appendix is broader in female fetuses than male fetuses.

Chaudari Manisha L⁹⁰, (2013) studied the morphology of vermiform appendix in 200 cases. The most common position in male and female was retrocaecal in 55% and 56% respectively. The least common position in male was sub-hepatic with 0.007% and in female was paracaecal with 0.04%. The average length in male was 5.6cm and in female was 5.4.cm. The average

external diameter was 7mm in male and 6mm in female. Studying various positions of vermiform appendix was helpful to understand the possible outcome of the appendicitis by specific location of site of pain.

Ravindra Kumar Boddeti⁹¹, (2013) reported an unique 28cm long vermiform appendix located in retrocaecal position. It may cause problems like acute appendicitis, torsion etc... and simulate enteritis, salpingitis in inflamed conditions

Janardhana Rao M⁹², (2014) presented a variation in arterial supply at human vermiform appendix. They found the branch of lower division of ileocolic artery passed anterior to terminal ileum entered mesoappendix and ran towards the tip of the appendix and lie on the wall of appendix. An accessory appendicular artery arose as a recurrent branch in the free border of mesoappendix and anastomosed with posterior caecal artery.

Sangram Keshari Panda⁹³, (2014) reported an usual association of Meckel's diverticulum with double appendix in 24 year old man. Concomitant malformations or duplication of large intestine or the genitourinary system may be present especially in type B₁ and C according to modified wall bridge classification (1963).

Patil BG⁹⁴, (2014) analyzed the position, length and arterial supply of vermiform appendix in South-Indian population. In their observations, the position of the appendix was retro caecal 20% the highest The average length of appendix in males was 7.5cm and 6cm in females. The arterial supply was

same in both sexes from inferior division of ileocolic artery 99% and from arterial loop was 1%.

Philip Mwachaka⁹⁵, (2014) studied the variations in the position and length of the vermiform appendix in a Black-Kenyan population with 48 cadavers. Retrocaecal was the commonest type in male and in females, pelvic and subileal. (36.4%). The paracaecal type was longest appendix, 110mm, shortest appendix was sub-hepatic 63mm. The average length was 76.5+23.6mm. The average distance between anterior superior iliac spine and umbilicus was 158.3+17.9mm. The base of the appendix was located along the spinoumbilical line in 52%

Ahmad Ghorbani⁹⁶ (2014) done a research regarding variation in the anatomical position of vermiform appendix among Indian Population in 200 cadavers. They observed the position of vermiform appendix, most common of pelvic 55.8% and least, preileal 1.5% only. The mean length of the vermiform appendix in males 91.2mm and in females 80.3mm. Mesoappendix complete in 79.5% and mesoappendix seen incomplete in age group below 10 years. No association was found between sex and anatomical position of vermiform appendix.

Nikhil Kumar Das⁹⁷ (2014) recorded the position of appendix in 16,128 Indian patients and observed position of vermiform appendix commonest retrocaecal 51% and least common was ectopic 0.03%. Retrocaecal position, the commonest in males 56% and pelvic position was the commonest in

females 48%. In the vegetarians, pelvic variety and in non-vegetarians retrocaecal was most common. Appendicular position with pathology showed that retrocaecal position was the highest in 58% and pelvic variety was highest in non-appendicular pathology.

Nilesh Ashok Salwe⁹⁸ (2014) studied the morphological variations of vermiform appendix and caecum in 60 cadavers of western Maharashtra region. Retrocaecal position was the commonest in both male (23%) and female(33%).Average length of the appendix 5.93cm.Average outer girth of appendix 2.8cm.Average distance of appendix from ileo caecal junction was 2.47cm.

Sanjay kumar sinha⁹⁹ (2014) observed the anatomical variations of vermiform appendix in Kosiregion, Bihar. In their observation the appendix position was retrocaecal in 63% of males and 58% of females. Average length of the appendix in males 5.46 cm and in females 4.02 cm. Mesoappendix reach up to the tip in males was 95% and in females 92%. In 84% males AA arises from inferior division of ileo-colic artery and in 14% directly from ileo-colic artery. Accessory Appendicular artery was found in 2%. The area of tenderness in appendicitis depend upon the length, position, part, inflammation and direction of appendix.

Sando Cilindro de souza¹⁰⁰, (2015) evaluated the frequency of the relative positions and length of vermiform appendix in 377 cases, in Salvador, Brazil. The observations were most common position of the appendix was

retrocaecal 43.5%. The appendix length ranged from 1.0 to 20.0cm (mean = 11.4cm). Most retro-caecal appendices were resting freely on the retrocaecal recess, only in 1.2% the mesoappendix was absent and appendix was completely adhered to caecum or ascending colon.

Suyakumari¹⁰¹ (2015) conducted a fetal specimen study in 62 cases. Retrocaecal position 29.5% was the commonest and then paracaecal 19.67%. Complete mesoappendix seen in 91.8% and one case of agenesis was reported. In 85.24% of cases origin of appendix was from posteromedial wall higher than medial wall. The average length was 24.10mm and breadth was 2.67mm. AA took origin mostly from inferior division of ileocolic artery.

Malarski¹⁰² (2015) discovered the variant position and size of the vermiform appendix in 70 years old male. Appendix was retroperitoneal and retrocaecal and close to liver and the length was very long about 16.3cm and diameter was 0.8cm. The descending colon was directed right and oblique towards caecum, make the case interesting for abdominal surgeries. Positional variation of the colon and mesoappendix can be explained by the common embryonic origin.

Uma Maheswara Rao¹⁰³ (2015) studied the variations of positions of VA, length, breadth, extent of MA and vascular supply in 50 cadavers. Most common position was retrocaecal 66% and no paracaecal position. In males, the average length was 77.22mm and breadth was 12.42mm. The average length was 69.33mm and breadth was 10.80mm. Mesoappendix was complete in 34%

and failed to reach tip in 66% of cases. There was single AA in 70% of cases and 2 AA in 30% of cases.

Naveena Swargam¹⁰⁴ (2015) determined the incidence of various caeco appendicular position Which help in surgical intervention in complicated typical and atypical caeco appendicular positions Most common postions was retrocaecal 44% and the highest incidence of subcaecal position (18%).

Ehah, I. et Amin¹⁰⁵ (2015) studied the length and position of vermiform appendix among Sudanese cadavers. The retrocaecal position seen in 60%, Pelvic in 35%, Postileal in 60% and Preileal in 1.7%. The length of the appendix was <69mm in 23.3% 70 – 110mm in 60% and >110mm in 16.7%. The study showed insignificant difference between length and age (P <0.08) and between males and females (P=0.23). P-value (0.04) was significant between age and position of vermiform appendix.

Sugunkara Rao¹⁰⁶ (2015) reported situs inversus totalis in 16 years old male. on laparoscopy it was (L) sided appendicitis and Laparoscopic appendicetomy done.

Kasukurthy Ashalatha¹⁰⁷, (2016) observed that the average length of the appendix in males was 6.56cm ranging from 2.2 to 11.5cm and in females was 4.58cm and ranging from 3.3 to 6.2cm. The length of the appendix in males was more than females. Average diameter of appendix at base in adults 0.5cm, ranging from 0.3 to 0.8cm. Average distance between ileocaecal junction to appendix in adults was 1.65cm, varies from 0.42 - 3cm and in fetuses was 0.39cm ,varies from 0.2 - 0.8cm. Pelvic Position was more 57.57%

in adults and paracaecal position was 39% in fetuses. Mesoappendix was of complete Variety 19 specimens and incomplete variety 14 specimens. A unique observation of single appendicular artery arising from inferior division of ileocolic artery in all adult specimens observed.

Shashikala Patel¹⁰⁸ (2016) studied the length of appendix in 50 cadavers. They found normal appendix (2-20cm) in 92% with mean length 6.98cm. Short length appendix seen in 4% with length 1.5cm. In young age group, long length appendix seen in 4% with mean length 21cm. Knowing length of the appendix helps on time diagnosis in acute appendicitis.

Bharti JP¹⁰⁹, (2016) conducted a morphological and histological study on vermiform appendix in Rabbit, goat and human beings. The results were the ratio of length of human appendix and rabbit appendix was 0.87 and the common position was retrocaecal position in humans. Morphological and histological differences was observed in caecum and appendix in humans, goat and rabbit, in this study, was associated with their different food habits.

MATERIAL AND METHODS



Photo-1 Open Appendicectomy

Photo-2 → Instruments



MATERIAL AND METHODS

STUDY DESIGN

Descriptive study

VENUE OF THE STUDY

1. Department of surgery, GRH, Madurai medical college, Madurai.
2. Institute of Anatomy, Madurai medical college, Madurai.

SAMPLES OF THE STUDY

The morphology of vermiform appendix studied in 50 cases during abdominal surgeries conducted at surgical theatres in Government Rajaji hospital, Madurai,

STUDY DURATION

The study conducted from July 2014 to June 2016.

INCLUSION CRITERIA:

1. 50 Abdominal surgeries conducted at GRH, Madurai.
2. Age of the patients >10 to <65 years.
3. Both males and females selected.

STUDY MATERIALS

1. Measuring scale
2. Thread
3. Dissecting forceps
4. Scalpel
5. Gloves

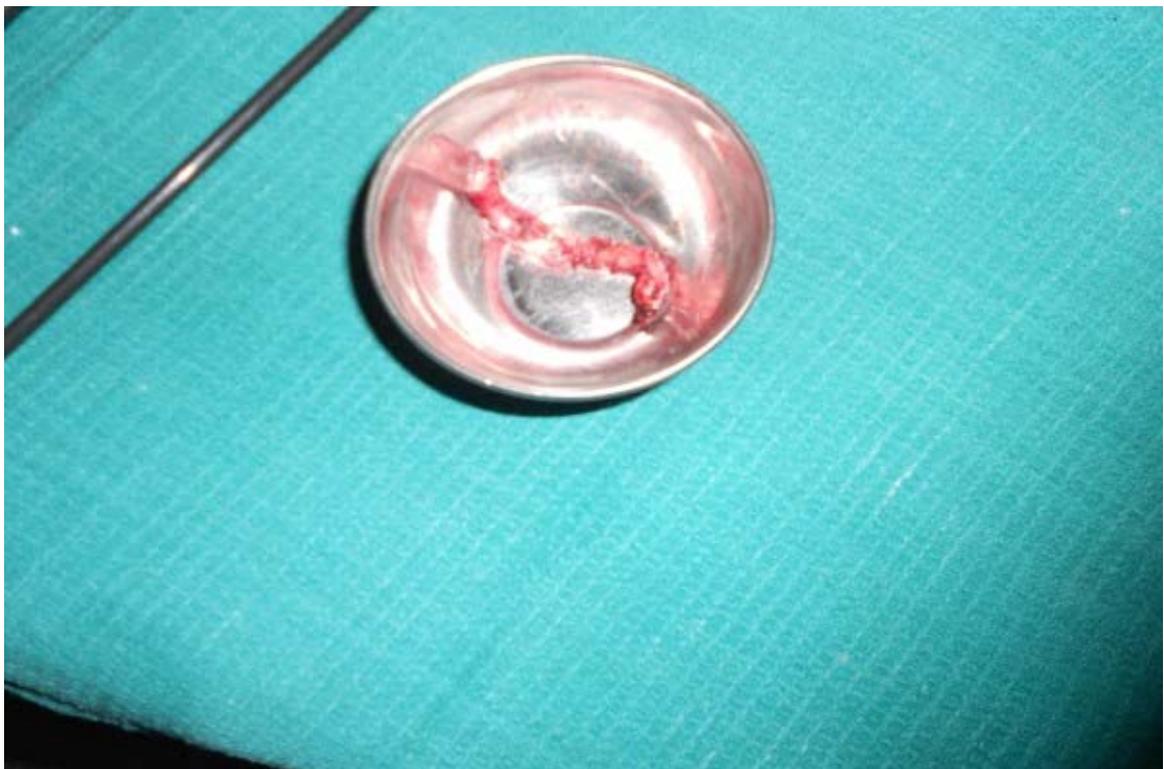


Photo -3 Appendix Specimen

6. Gauze and cotton
7. Digital camera

THE PARAMETERS:

The following parameters of the vermiform appendix was studied.

1. LOCATION OF THE APPENDIX

The abdominal region occupied by the vermiform Appendix was observed either right iliac fossa, right lumbar, umbilical or inguinal.

2. DIRECTION OF THE TIP

The position of the appendix was confirmed by the direction of tip of the appendix

3. CLOCK POSITION OF THE APPENDIX

The clock position occupied by the tip of the appendix as 12 o' clock, 11 o'clock, 2 o'clock, 5 o'clock & 6 o'clock.

4. POSITION OF BASE OF APPENDIX IN RELATION TO CAECAL WALL

The situation of base of appendix in the wall of caecum either anterior, posteromedial, lateral or lower pole was observed

5. POSITION OF SHAFT OF APPENDIX IN RELATION TO CAECUM/ILEUM

The position occupied by the vermiform appendix according to tip of the appendix-Retrocaecal, para caecal, splenic, pelvic, midinguinal (or) subcaecal was observed.



MEASURING THE LENGTH OF APPENDIX

6. DISTANCE OF THE BASE OF THE APPENDIX AND ILEO-CAECAL JUNCTION

The distance from base of the appendix to ileo caecal junction was observed.

7. RELATION OF THE BASE TO SPINO- UMBILICAL LINE

The relation of base of appendix either corresponding, above or below to spinoumbilical line was observed.

8. THE LENGTH OF THE APPENDIX

The length of the appendix was measured from base to the tip in the surgical specimens resected, using measuring scale.

9. EXTERNAL DIAMETER OF THE APPENDIX

The maximum diameter of the appendix was measured in surgically resected specimens.

10. EXTENT OF THE MESO APPENDIX

Whether the mesoappendix was complete (or) failed to reach the tip of the appendix was observed.

11. NUMBER OF APPENDICULAR ARTERY

The number of appendicular artery either single (or) more than one was observed.

12. ANOMALY OF THE APPENDIX

Any agenesis, duplication, triplication or abnormal location was noted.

ETHICAL COMMITTEE CLEARANCE

Approval from ethical committee obtained.

Statistical Analysis:

The information collected regarding all the selected cases were recorded in a master chart. Data analysis was done with the help of computer by using SPSS 16 software and Sigma Stat 3.5 version (2012). Using this software mean, standard deviation and 'p' value were calculated through one way ANOVA, Chi square test and P value of < 0.05 was taken as significant.

ANATOMY

The vermiform appendix is a narrow blind-ended intestinal diverticulum. It is round worm-like (L vermiformis), hence called vermiform appendix. It joins the postero-medial wall of caecum 2cm inferior to the ileocaecal junction. It usually lies in the right iliac fossa but its tip varies in position. It is devoid of taenia coli, sacculations and appendices epiploicae.⁴

The average length of the appendix is 6 to 9cm, but it can vary from < 1 to >30cm. The outer diameter ranges between 3 and 8mm while its lumen diameter ranges between 1 and 3mm.¹¹⁰ The appendix grows in length and diameter in childhood attains mature dimensions by 3 years and diminishes after mid-adult life.

The vermiform appendix has base, body and tip. The base is constant in position and is identified by the convergence of taenia coli inside the

abdomen. It serve as a guide for identification of the appendix during surgeries. The surface marking of the base of the appendix has been traditionally described as Mc Burney's point which presents at the junction of medial two-third and lateral one-third of spinoumbilical line. The body of appendix is tubular in shape and opens into the caecum. The caecal opening is guarded by "The Valve of Gerlach" an incomplete mucous fold.¹¹¹

The tip of the vermiform appendix occupies following various positions Retrocaecal & Retrocolic(12o'clock position)-commonest type and occupies more than 60%. The tip runs vertically upwards behind caecum and colon retroperitoneally.

Splenic (2o'clock)- 1to2% .The tip passes obliquely and medially and runs in front or behind terminal ileum.

Promontic (3o'clock)-very rare, the tip is directed towards sacral promontory.

Pelvic (4o'clock)-second commonest type and more than 30%.The tip passed downwards and medially towards pelvic organs.

Para-caecal (11o'clock position)- The tip runs parallel to caecum and ascending colon.

Sub-caecal (6o'clock)-The tip runs vertically downwards

Ectopic type-May be in left iliac fossa, umbilical or sub hepatic¹¹¹

The lumen is irregularly narrowed by submucosal lymphoid tissue. It may be widely patent in early childhood but often partially or wholly

obliterated in adults. Its lumen may be occluded by faecolith, foreign body or worms.⁶

The mesoappendix, a triangular fold of peritoneum extends between terminal ileum and appendix. It contains a variable amount of fat, lymphatics, nerves and frequently ends short of the tip of the appendix. Two appendicular vessels present in the free margin of the mesoappendix. Peritoneal folds from the posterior caecal wall may create a variety of peritoneal recesses around caecum that become the potential sites of internal herniation. The retrocaecal recess frequently contains the vermiform appendix.⁴

A small fold of peritoneum extends between the terminal ileum and the anterior layer of the mesoappendix called “Bloodless fold of Treves” and the space between it and the mesoappendix is Inferior- ileocaecal recess. Another fold of peritoneum runs between terminal ileal mesentry and anterior wall of caecum called vascular fold of caecum and containing anterior caecal artery. The space behind the fold is superior ileo-caecal recess.²

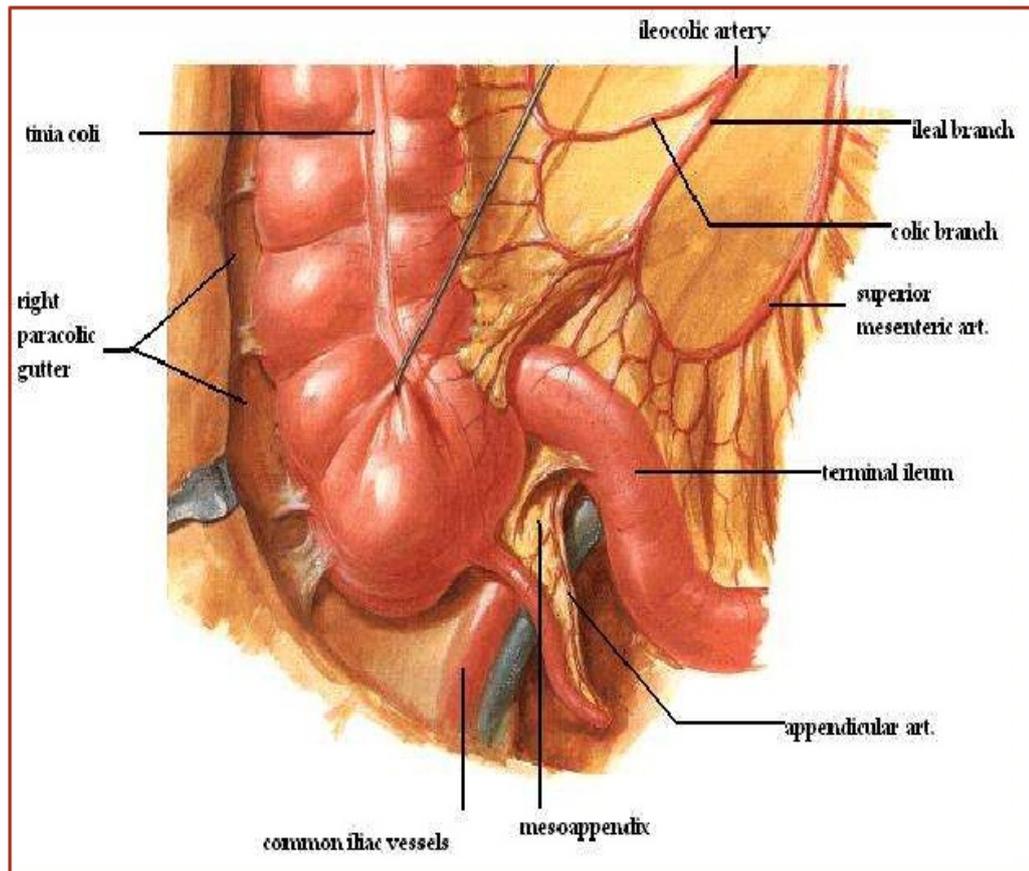


Fig.1.NORMAL ANATOMY

The vermiform appendix is supplied by an appendicular artery, which is a branch of the inferior division of ileo-colic artery. The AA runs behind the terminal ileum to enter the mesoappendix and it runs in the free margin of the mesoappendix. The AA is so short towards tip and rests over the appendicular wall and said to be an end artery. So in inflammation of appendix, the artery may be thrombosed, leading to ischaemic necrosis and perforation of tip early. Venous drainage flow through the ileocolic vein into superior mesenteric vein.

Lymphatic drainage of the appendix passes to the lymph nodes in the mesoappendix, then to the ileo-colic lymph nodes and finally drains into superior mesenteric nodes.

The appendix is supplied by the sympathetic and parasympathetic (vagus) nerves from the superior mesenteric plexus. Afferent fibres concerned with the conduction of visceral pain from the appendix accompany the sympathetic nerves and enter spinalcord at the level of the 10th thoracic segment, reason for referred pain in umbilicus in appendicitis.¹¹³

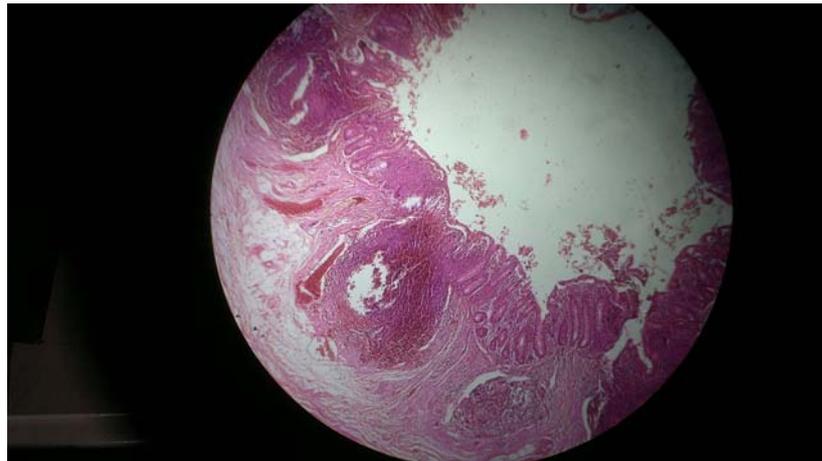


FIG.2.HISTOLOGY OF THE APPENDIX

Histologically, the appendix has four layers, namely outer serous, muscular, submucous and inner mucous .The serosa forms a complete covering of appendix except along the mesenteric attachment. The muscular layer consists of outer longitudinal and inner circular smooth muscles and gaps at some cites forming “Hiatus Muscularis”¹¹¹. The appendix is a significant component of Mucosa associated lymphatic tissue (MALT) with its lamina propria and submucosa filled with lymphocytes and lymphoid follicles. The small lumen contains normal bacterial flora of large intestine. The mucosa is lined by columnar absorbtive cells called colonocytes. Intestinal glands are fewer in number and less densely packed and penetrate deep into the lamina propria¹¹¹

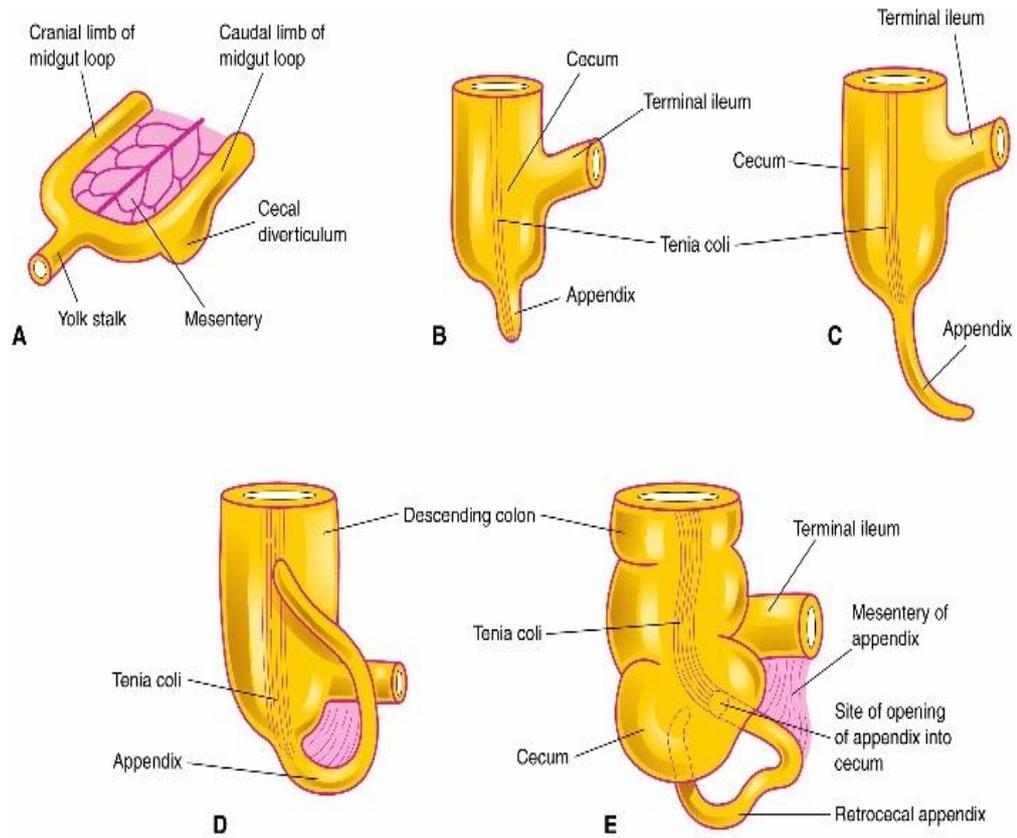


FIG.3.EMBRYOLOGY OF APPENDIX

Embryologically the caecum and appendix develops as outpouchings from the caudal limb of the midgut. By fifth week, the presumptive ileum which can be distinguished from primitive colon by caecal primordium, lengthens and forms primary intestinal loop. The loop has cranial limb, caudal limb and an apex connected by vitelline duct to umbilicus. By sixth week, the midgut loop herniates into umbilicus and rotates around the axis of superior mesenteric artery by 90degrees counterclockwise .Thus jejuno-ileal loops formed and the expanding caecum sprouts as a vermiform appendix. By tenth week, midgutloop reenters abdomen, it rotates 180 degrees anticlockwise and now caecum with appendix descends to right lower quadrant. The subsequent

unequal growth of the lateral wall of caecum causes the appendix to move to its adult position on the posteromedial wall below the ileocaecal valve. In case of midgut malrotation and situs inversus, the position of appendix may be pelvic, left sided or subhepatic (ectopic).¹³⁰

OBSERVATIONS

OBSERVATIONS

The morphology of vermiform appendix was studied in fifty cases during abdominal surgeries and the following observations were noted.

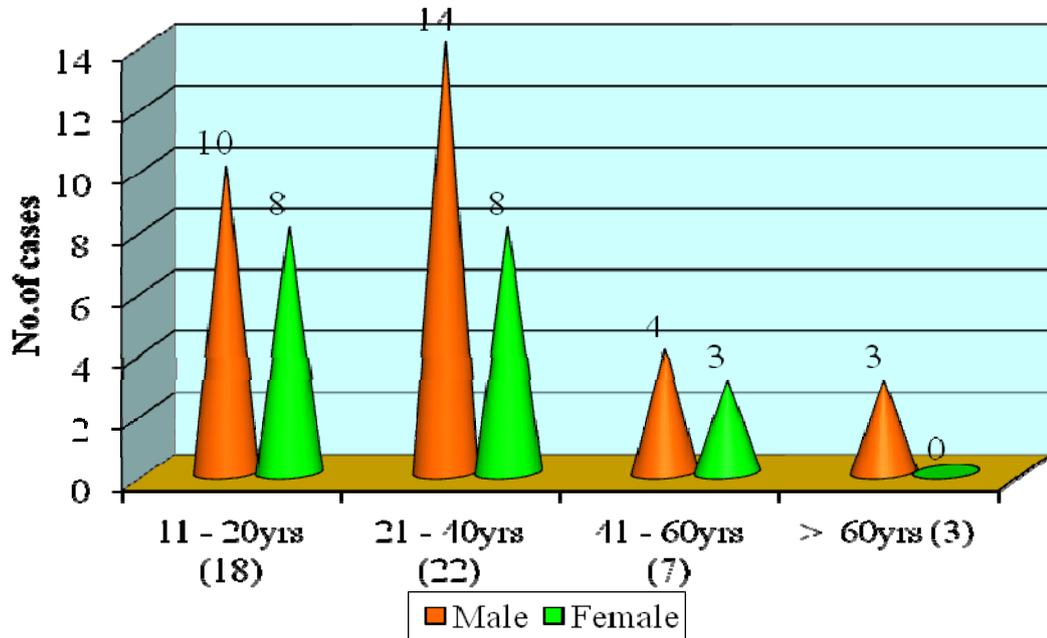
Table: 1

AGE DISTRIBUTION

| S. No | Age | Sex | | Total |
|-------|------------|------|--------|-------|
| | | Male | Female | |
| 1 | 11 - 20yrs | 10 | 8 | 18 |
| 2 | 21 - 40yrs | 14 | 8 | 22 |
| 3 | 41 - 60yrs | 4 | 3 | 7 |
| 4 | > 60yrs | 3 | - | 3 |
| Total | | 31 | 19 | 50 |

The age distribution ranged between 13 – 68 years in males and 14 -52 years in females. In the present study there were 31 males and 19 females.

AGE DISTRIBUTION



1. Between 11 – 20 years, there were 10 males and 8 females and totally 18 cases.
2. Between 21 -40 years there were 14 males and 8 females totally 22 cases.
3. Between 41 – 60 years, there was 4 males and 3 females.
4. Above 60 years, only 3 males.

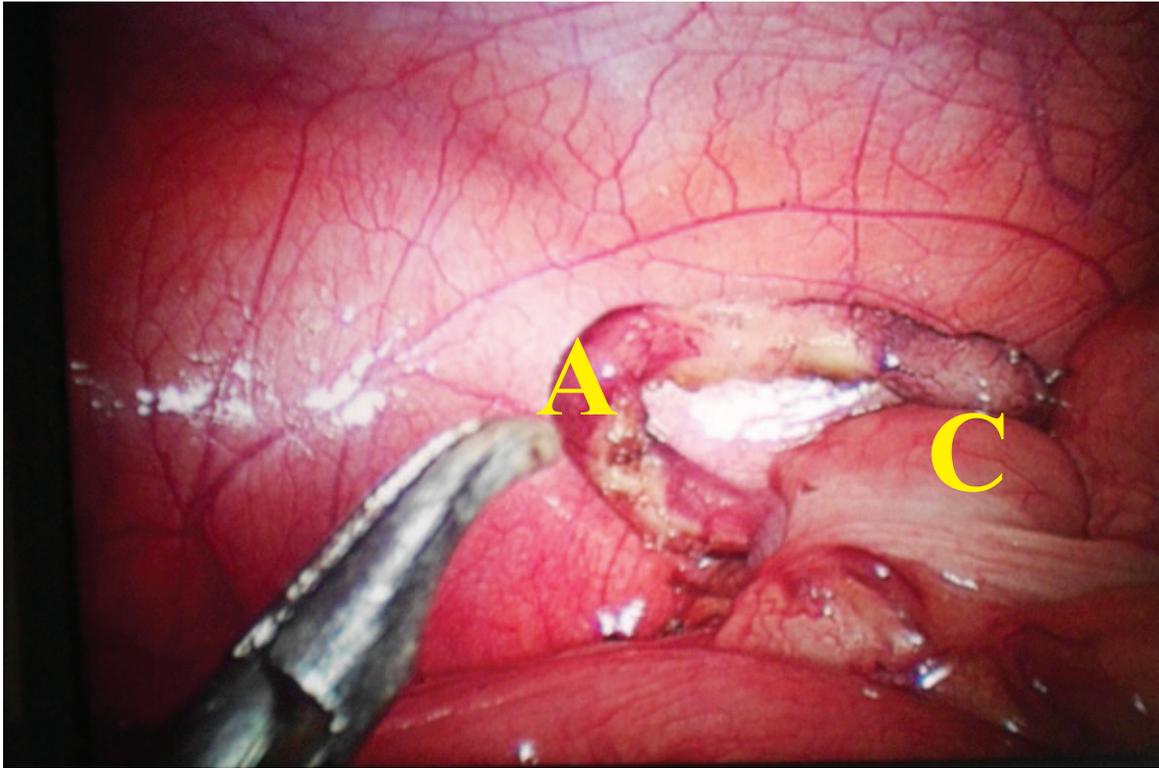


Photo -4 Appendix in Right Iliac fossa

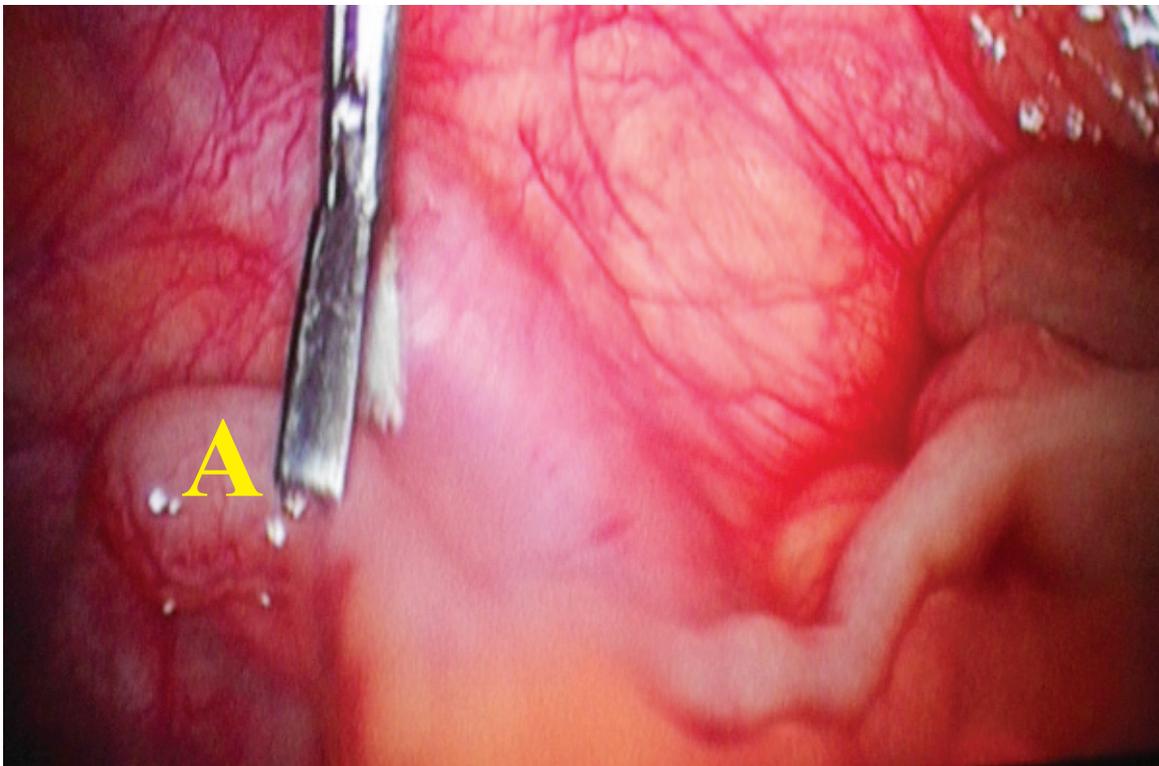


Photo - 5 Appendix in inguinal region

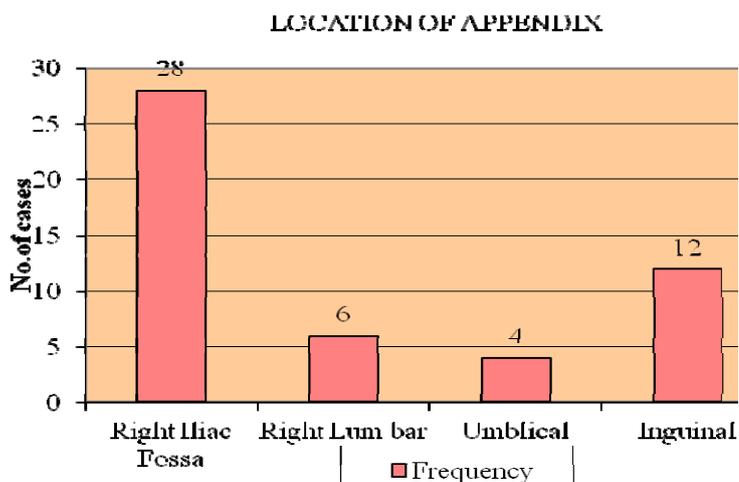
Table: 2

Location of the appendix

Normally the appendix was located in right iliac fossa but also present in left iliac fossa, sub hepatic or inguinal region

| S.No | Location of Appendix | No of cases | Frequency % |
|------|----------------------|-------------|-------------|
| 1. | Right Iliac Fossa | 28 | 56 |
| 2. | Right Lumbar | 6 | 12 |
| 3. | Umbilical | 4 | 8 |
| 4. | Inguinal | 12 | 24 |

In the present study it has been observed that the appendix was located in right iliac fossa in 28 cases in right lumbar region in 6 cases, in umbilical region in 4 cases and in inguinal region in 12 cases. Most common location of the appendix is right iliac fossa (56%) followed by inguinal region (24%), in right lumbar region was 12% and umbilical region 8%.



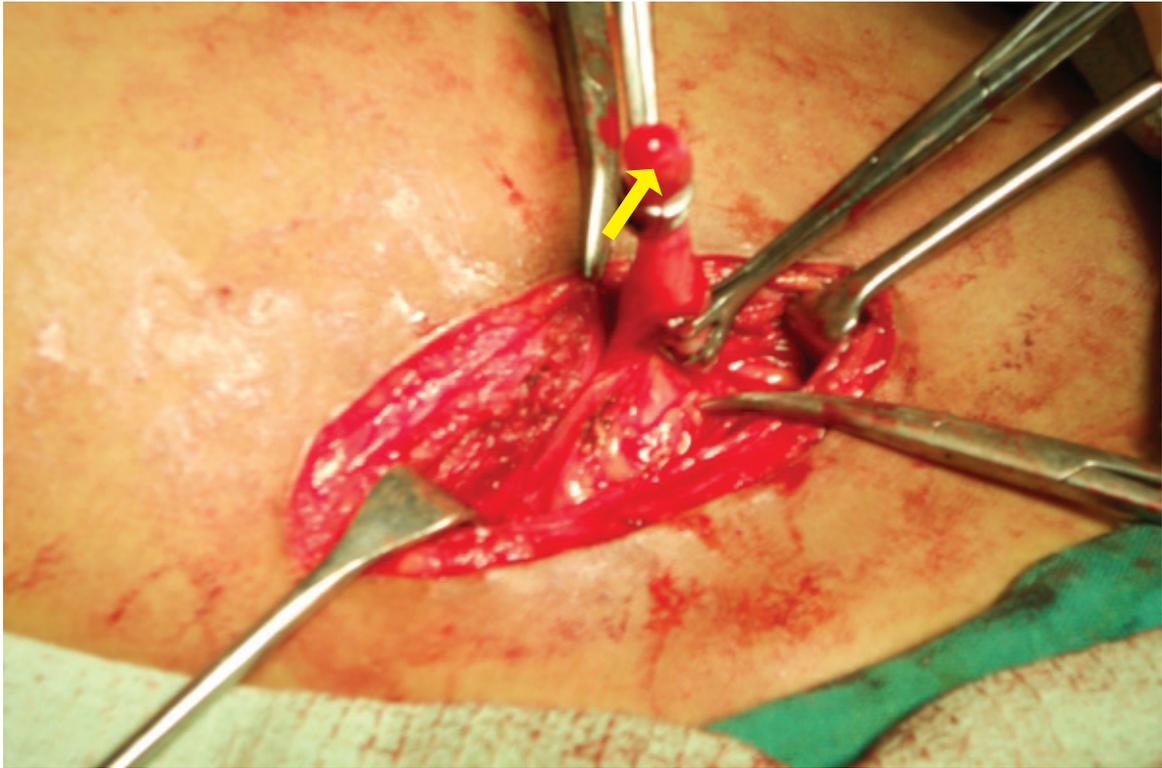


Photo - 6 12o' Clock Position

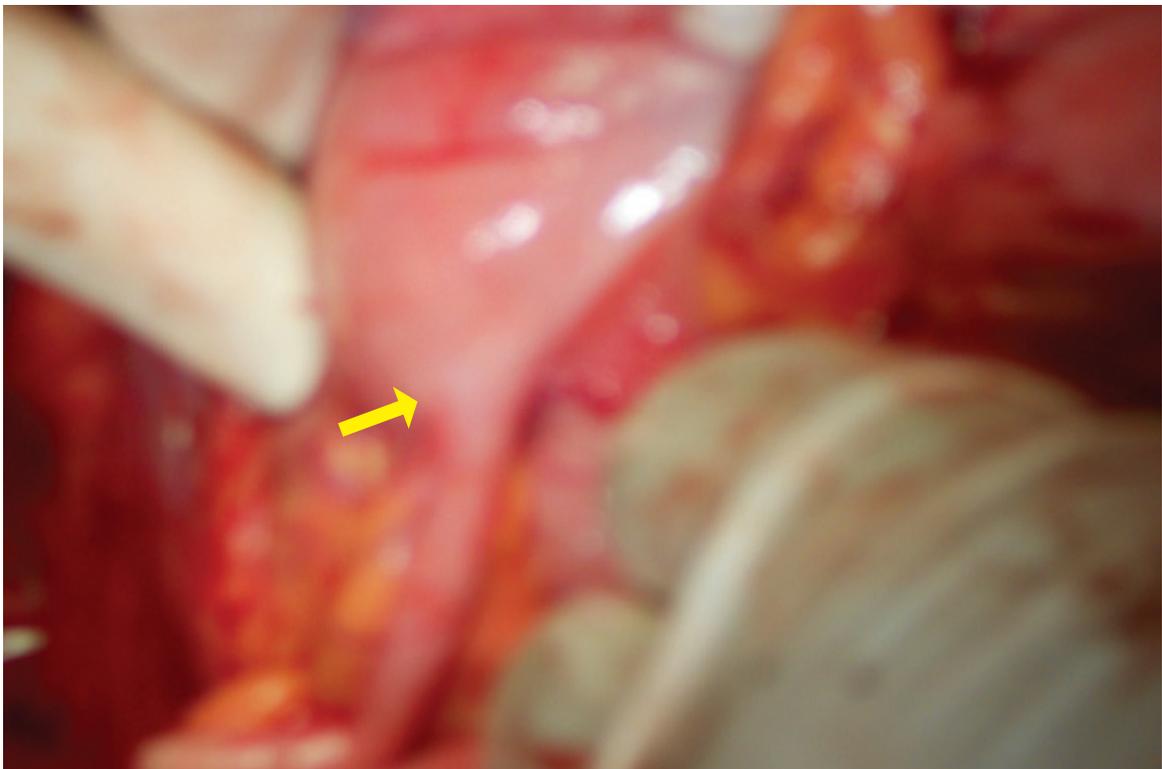


Photo - 7 6o' Clock Position

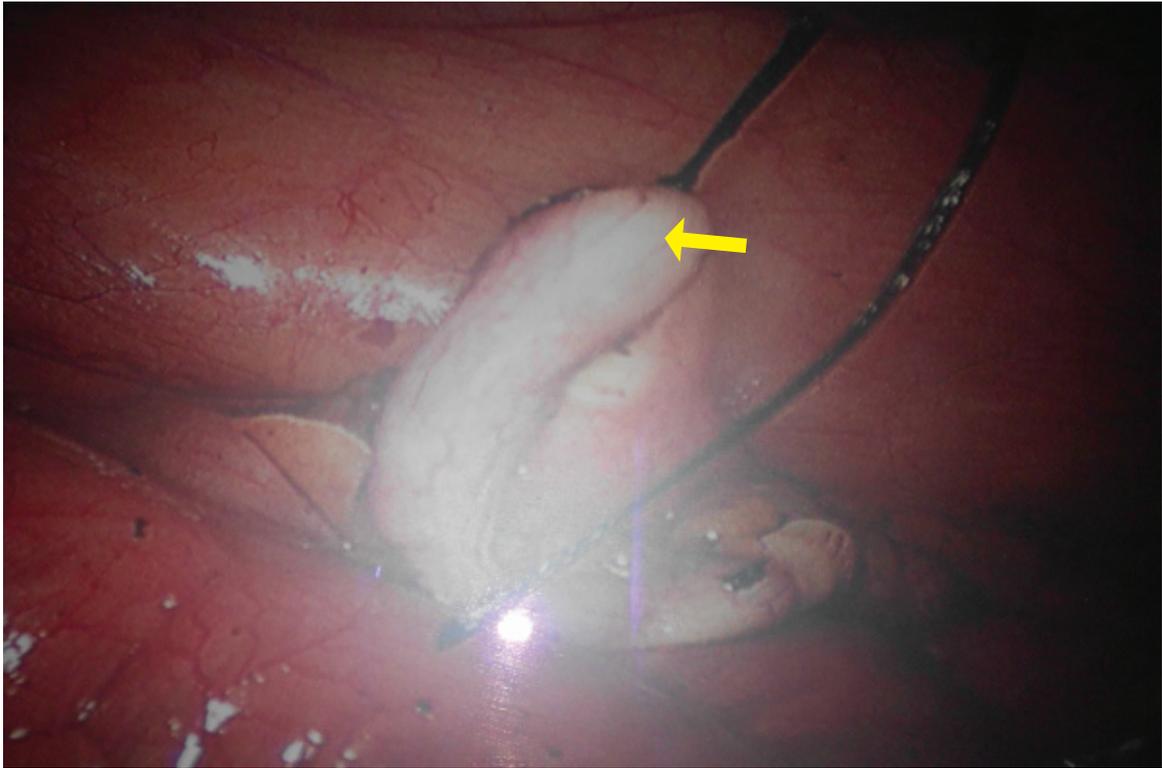


Photo - 8 2o' Clock Position

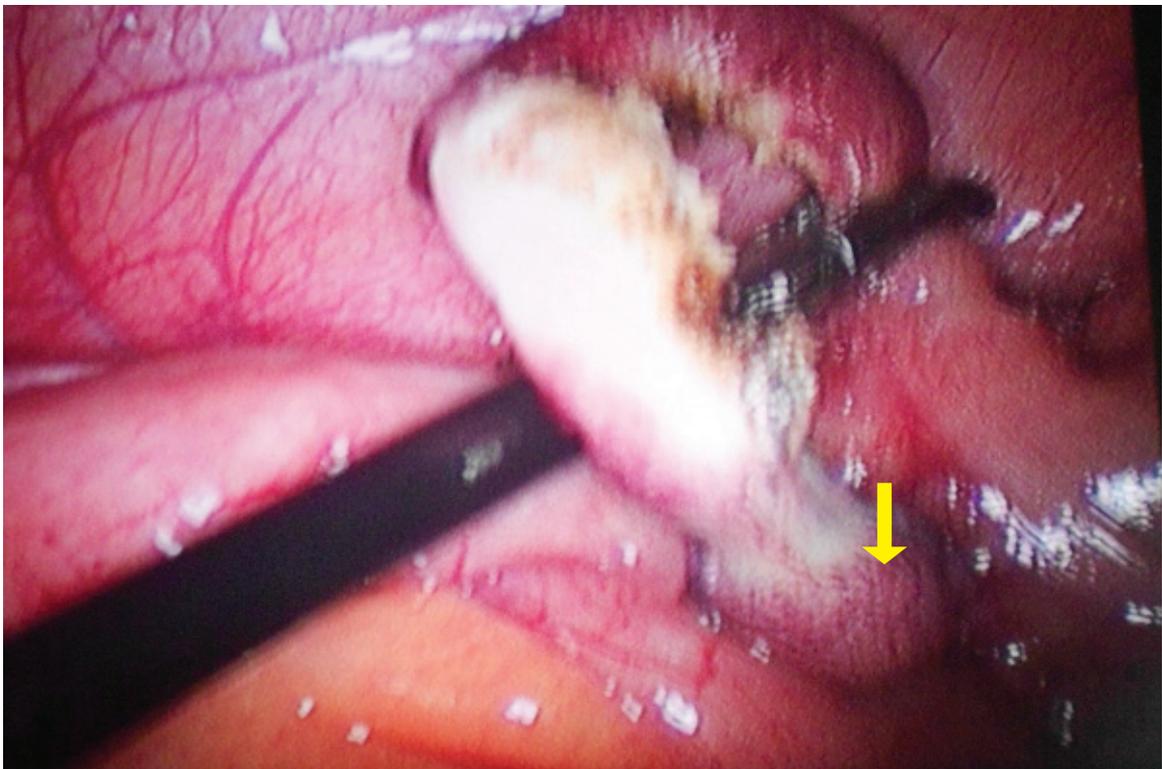


Photo - 9 5o' Clock Position

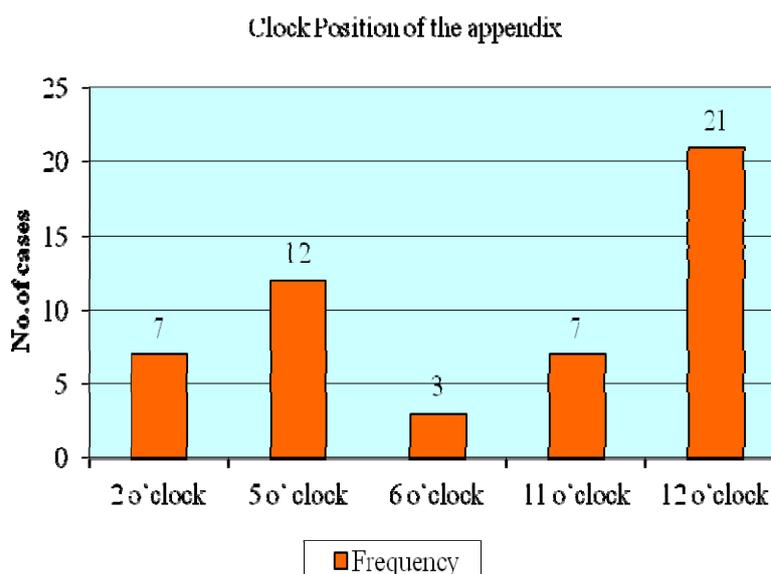
Table: 3

Clock Position of the appendix

In the present study following clock position were observed.

| S.No | Clock Position | No of cases | Frequency % |
|------|----------------|-------------|-------------|
| 1. | 2 o'clock | 7 | 14 |
| 2. | 5 o'clock | 12 | 24 |
| 3. | 6 o'clock | 3 | 6 |
| 4. | 11 o'clock | 7 | 14 |
| 5. | 12 o'clock | 21 | 42 |

In the present study 12 o'clock position (42%) was the commonest followed by 5 o'clock position (24%), 11 o'clock position (14%), 2 o'clock position (14%) and 6 o'clock position (6%). The occurrence of 12 o'clock position in 21 cases was higher followed by pelvic position in 12 cases.



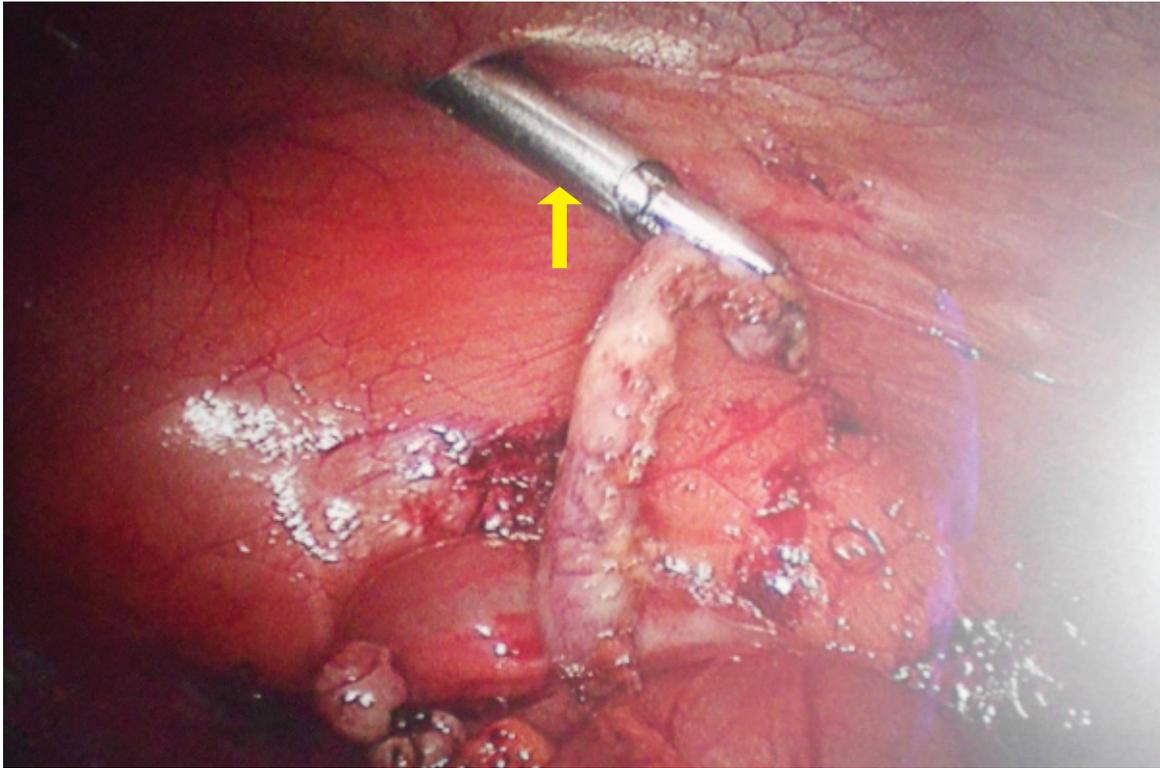


Photo - 10 Tip Directed Upwards



Photo - 11 Tip Directed Downwards

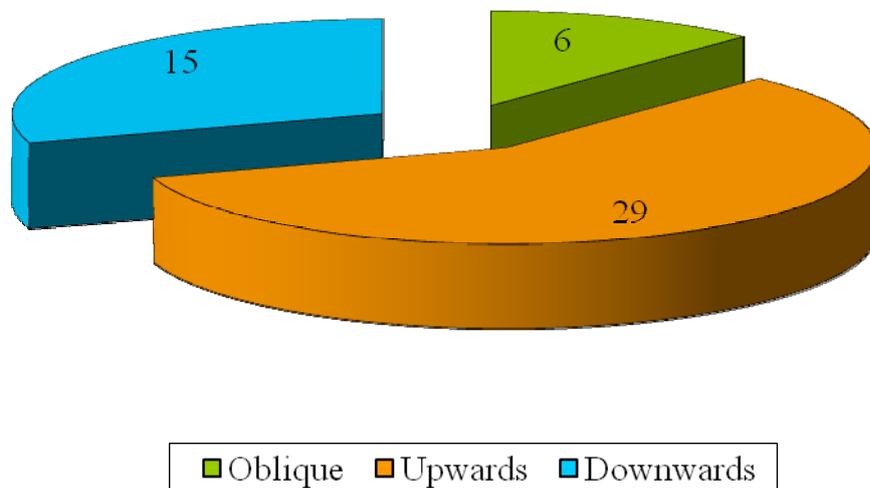
Table: 4

Direction of Tip

| S.No | Direction of Tip | No of cases | Frequency % |
|-------------|-------------------------|--------------------|--------------------|
| 1. | Oblique | 6 | 12 |
| 2. | Upwards | 29 | 58 |
| 3. | Downwards | 15 | 30 |

In the present study, direction of the tip was vertically upwards in 29 cases, oblique upwards in 6 cases and downwards in 15 cases.

DIRECTION OF TIP



Incidence of upward direction of tip of appendix (58%) is greater than downward direction (30%) and oblique direction 12%.

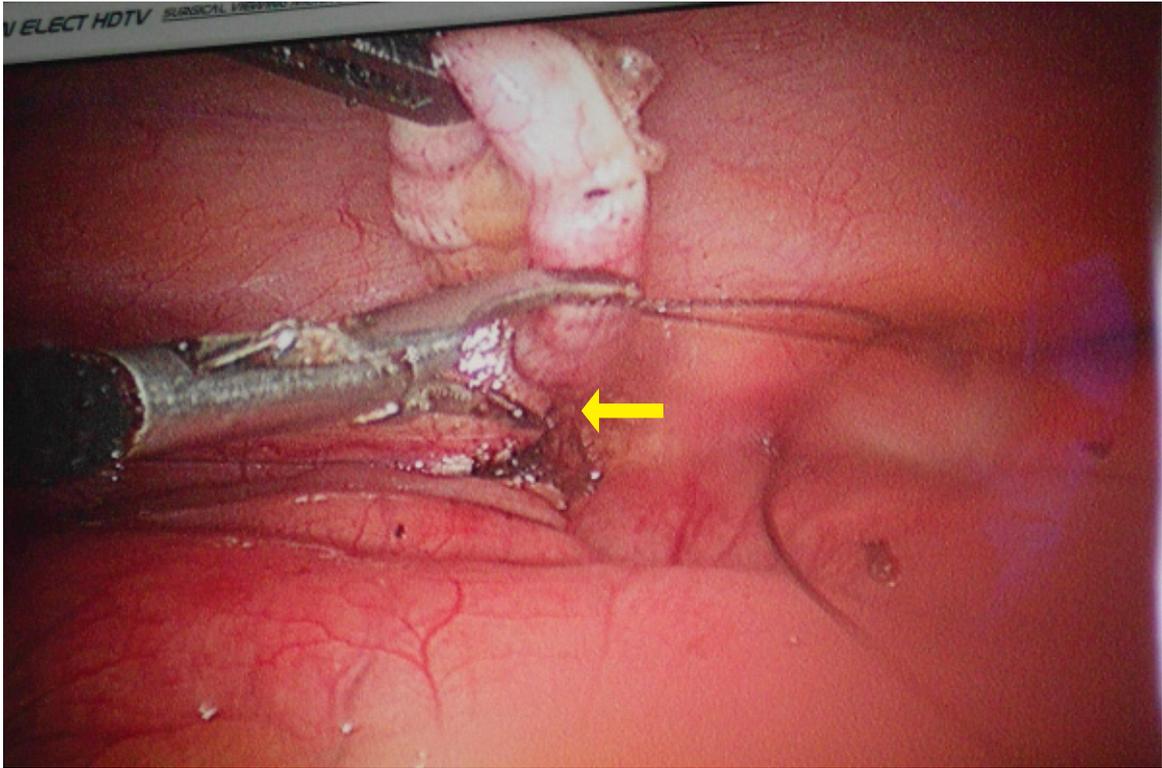


Photo - 13 Postero - Medial Caecal Wall

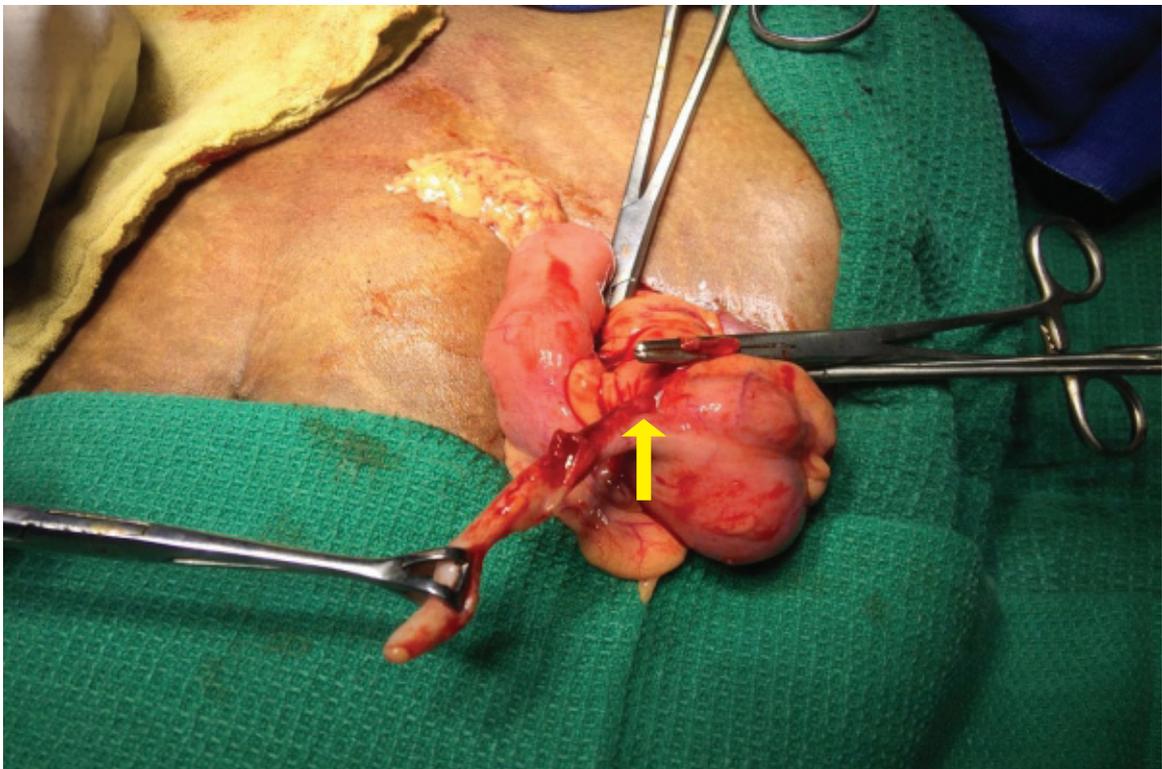


Photo - 14 Lower Pole of Caecum

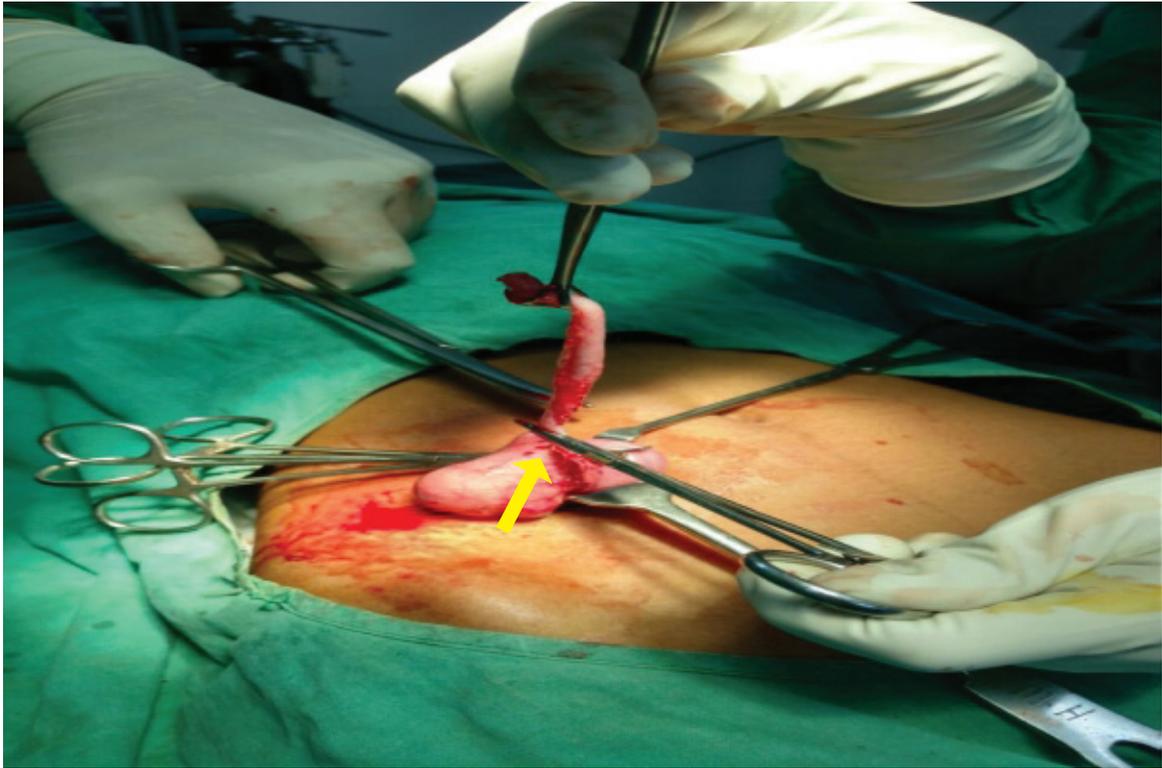


Photo - 15 Anterior Wall of Caecum

Table: 5

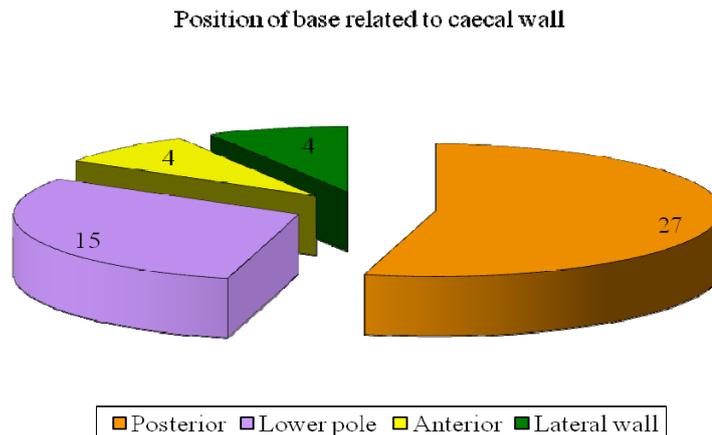
Position of base in relation to caecal wall

Normally the position of base of appendix is in posteromedial wall of caecum. It may also be present in anterior wall, lateral wall, medial wall or in lower pole

| S.No | Position of base related to caecal wall | No of cases | Frequency % |
|------|---|-------------|-------------|
| 1. | Posterior | 27 | 54 |
| 2. | Lower pole | 15 | 30 |
| 3. | Anterior | 4 | 8 |
| 4. | Lateral wall | 4 | 8 |

In the present study the position of base was in posteromedial wall in 27 cases, lower pole in 15 cases, anterior wall in 4 cases and lateral wall in 4 cases.

Percentage incidence of location of base of appendix in relation to the caecal wall in the present study is in posteromedial wall (54%) lower pole (30%) anterior wall (8%) and lateral wall (8%)



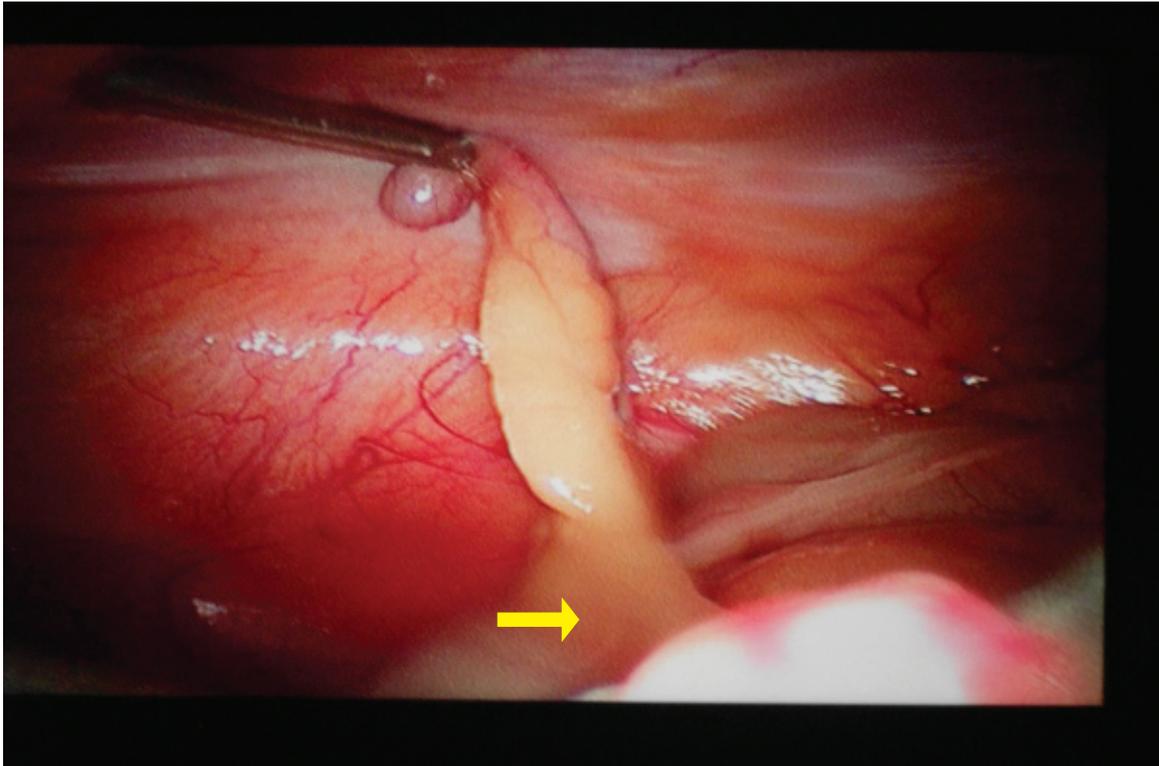


Photo - 16 Retrocaecal Position

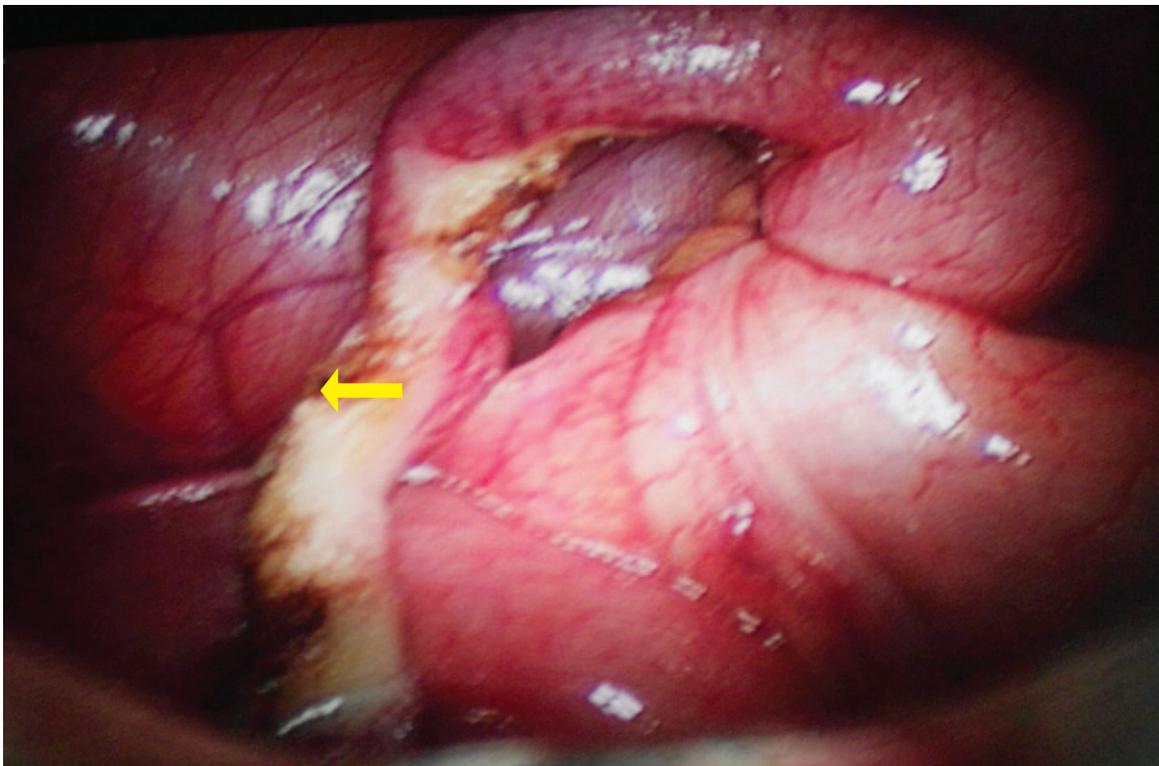


Photo - 17 Paracaecal Position

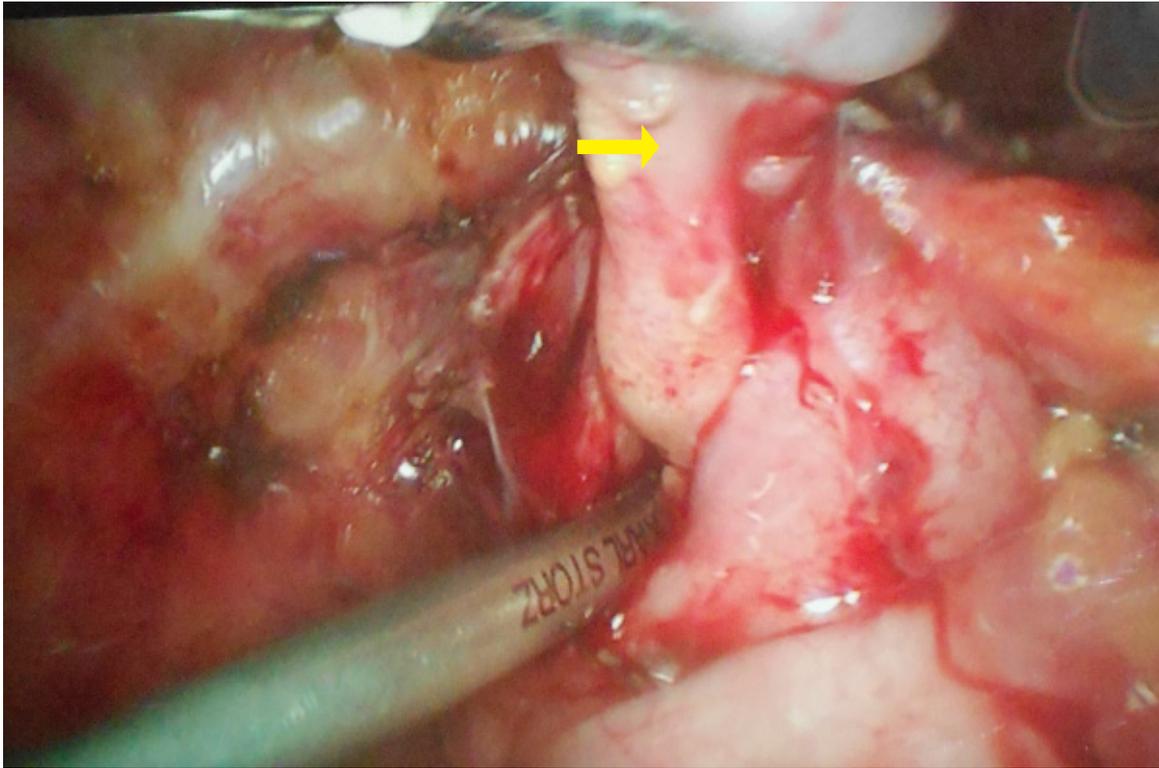


Photo - 18 Pre - Ileal Position

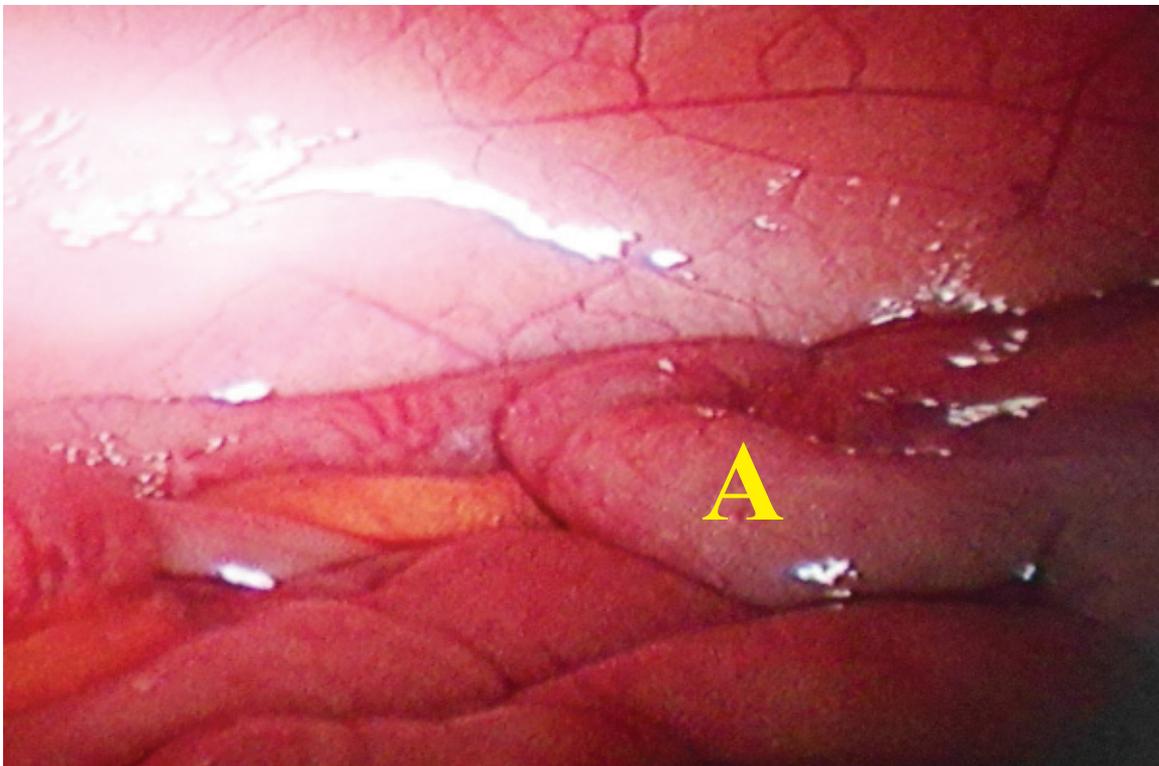


Photo - 19 Post - Ileal Position

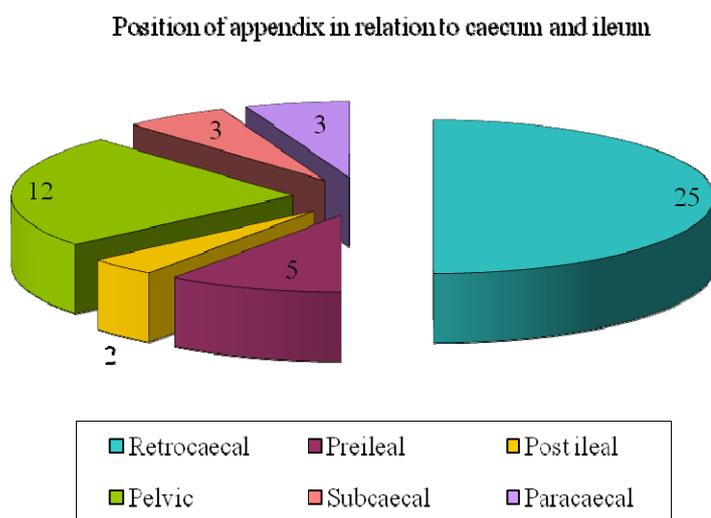
Table: 6

Position of appendix in relation to caecum and ileum

The most common is the retrocaecal position. Next is pelvic position followed by subcaecal, preileal, postileal and promontory?

| S. No | Position | Total number of cases | Percentage % |
|-------|-------------|-----------------------|--------------|
| 1. | Retrocaecal | 25 | 50 |
| 2. | Preileal | 5 | 10 |
| 3. | Post ileal | 2 | 4 |
| 4. | Pelvic | 12 | 24 |
| 5. | Subcaecal | 3 | 6 |
| 6. | Paracaecal | 3 | 6 |

In the present study, percentage incidence of retrocaecal position (50%) was higher when compared to other positions.



Retrocaecal position was the most common seen in 25 cases followed by pelvic position (12) and preileal position (5). The paracaecal (3) and Subcaecal position are equal (3) and the least common position was postileal (2).

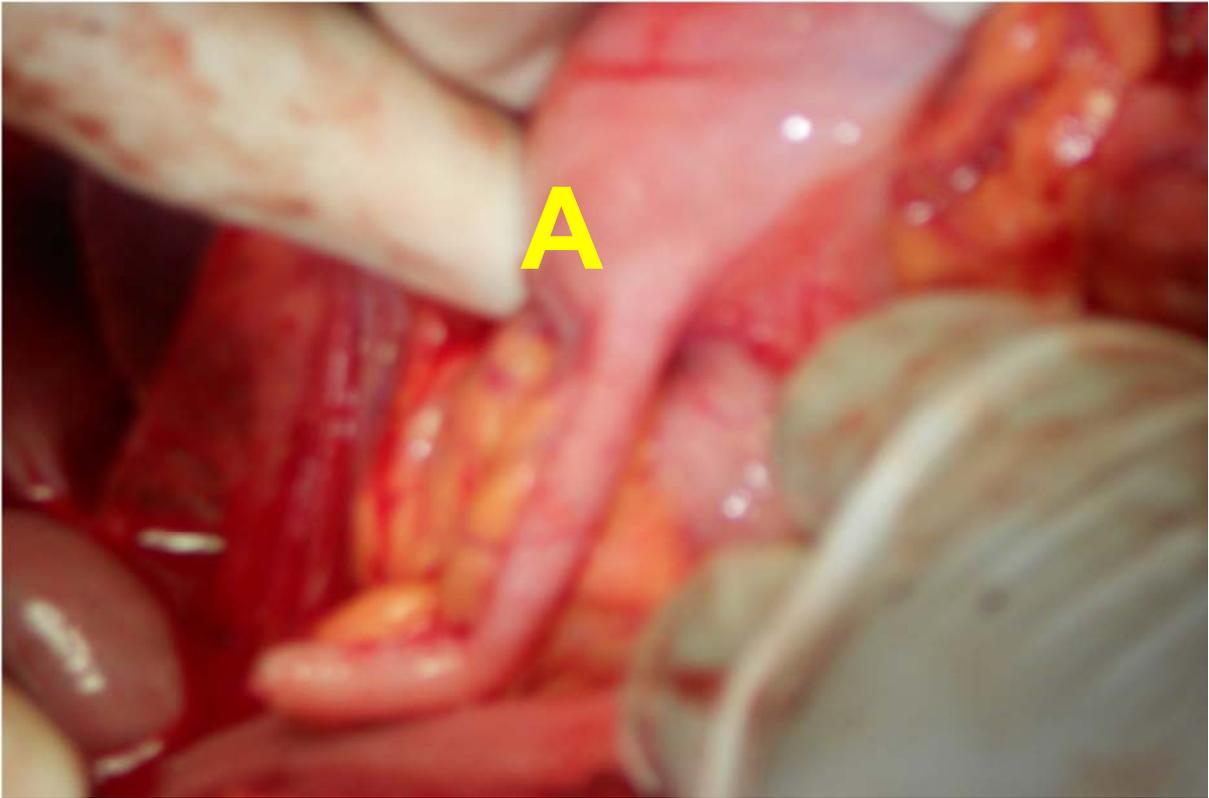


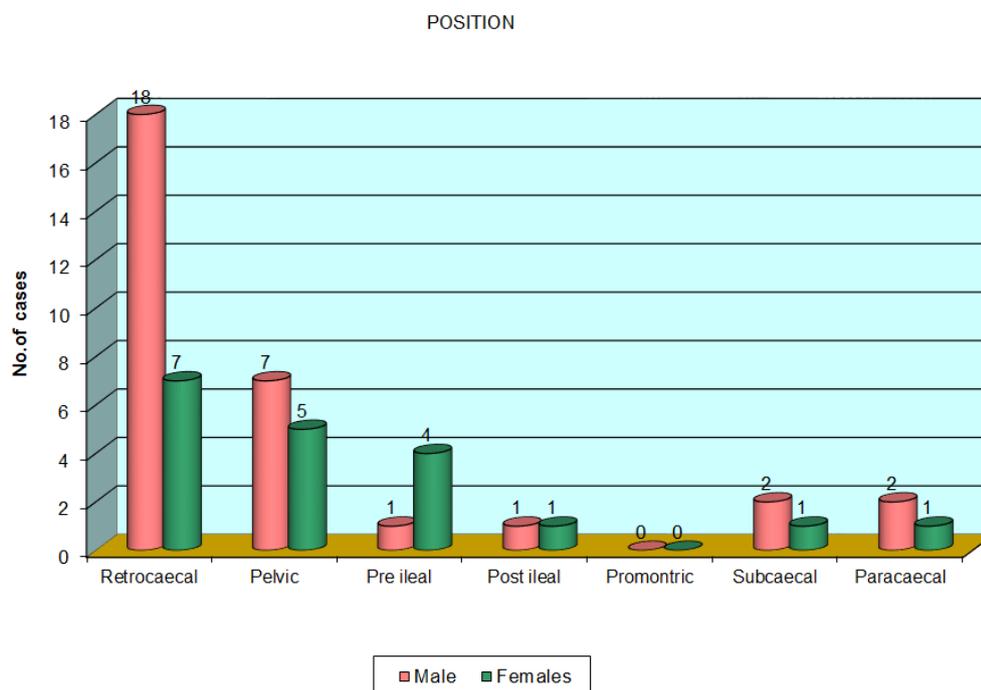
Photo - 20 Subcaecal Position

Table: 7

Association between position of the appendix and sex of the individual

| S.No | Position | Male | Female |
|------|-------------|------|--------|
| 1. | Retrocaecal | 18 | 7 |
| 2. | Pelvic | 7 | 5 |
| 3. | Pre ileal | 1 | 4 |
| 4. | Post ileal | 1 | 1 |
| 5. | Subcaecal | 2 | 1 |
| 6. | Paracaecal | 2 | 1 |

Retro caecal position was most common in both males and females in present study. The least common position was postileal in both sexes.



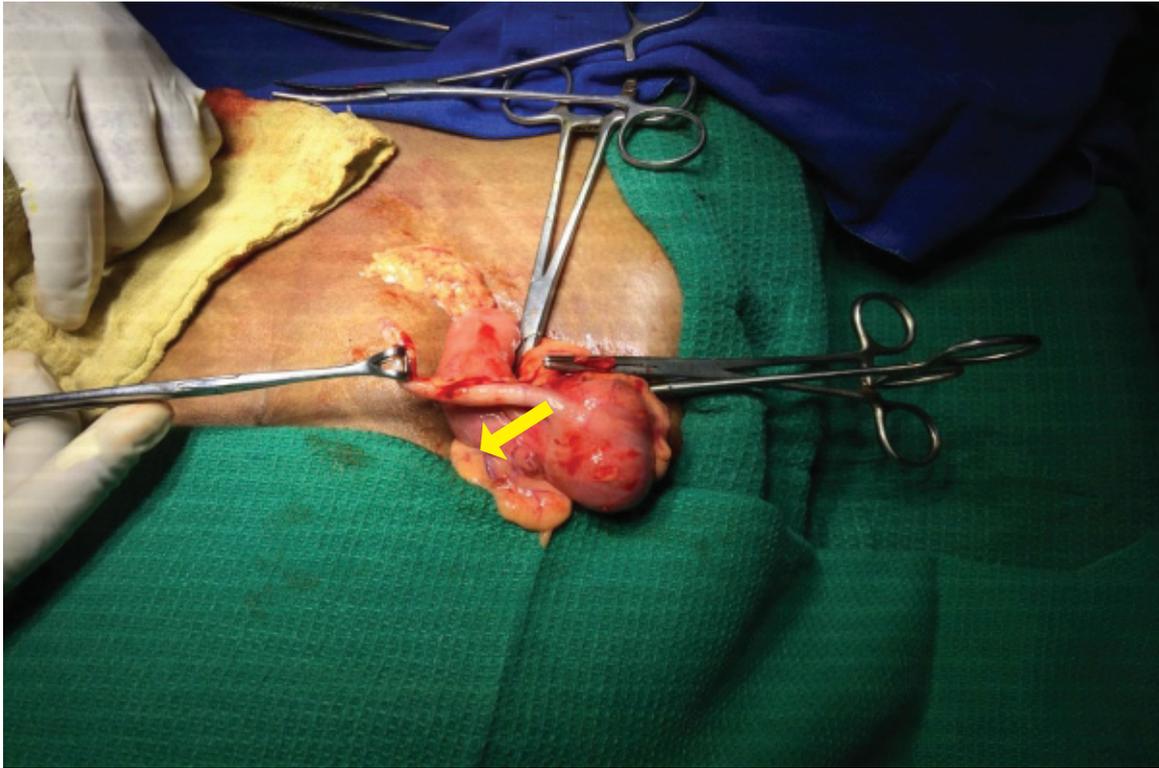


Photo - 24 Maximum Distance of Base to ICJ

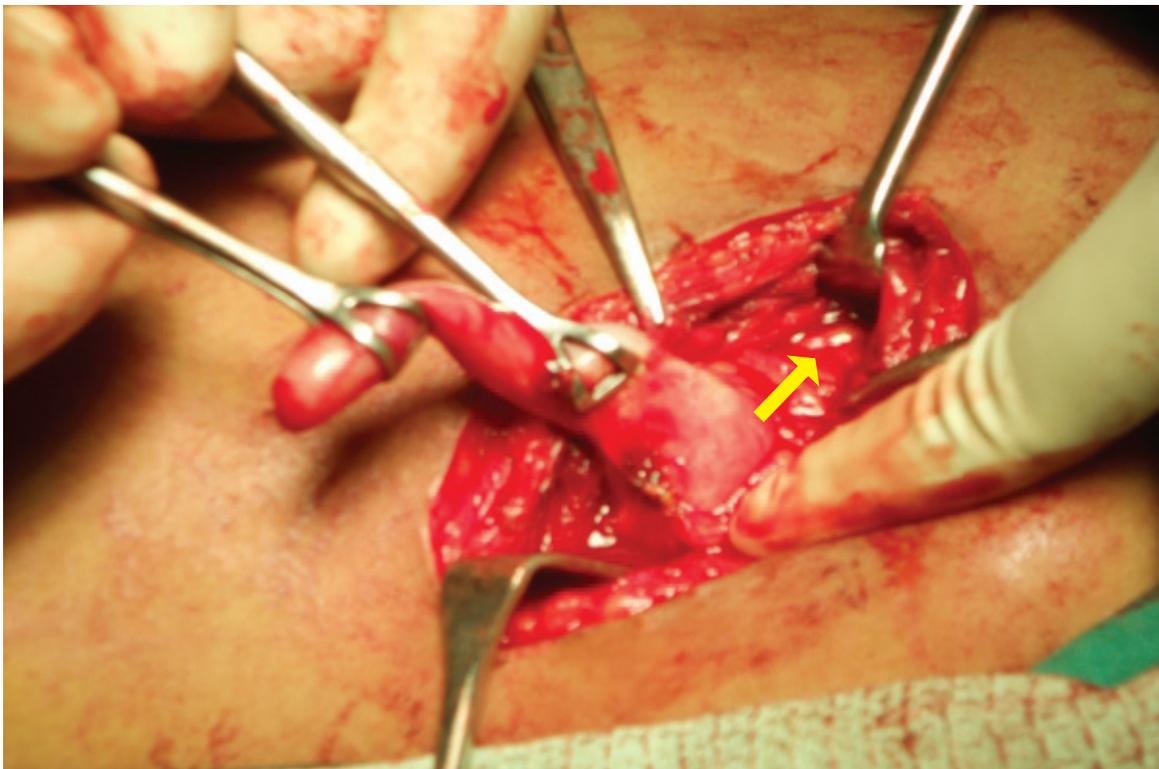


Photo - 25 Minimum Distance of Base to ICJ

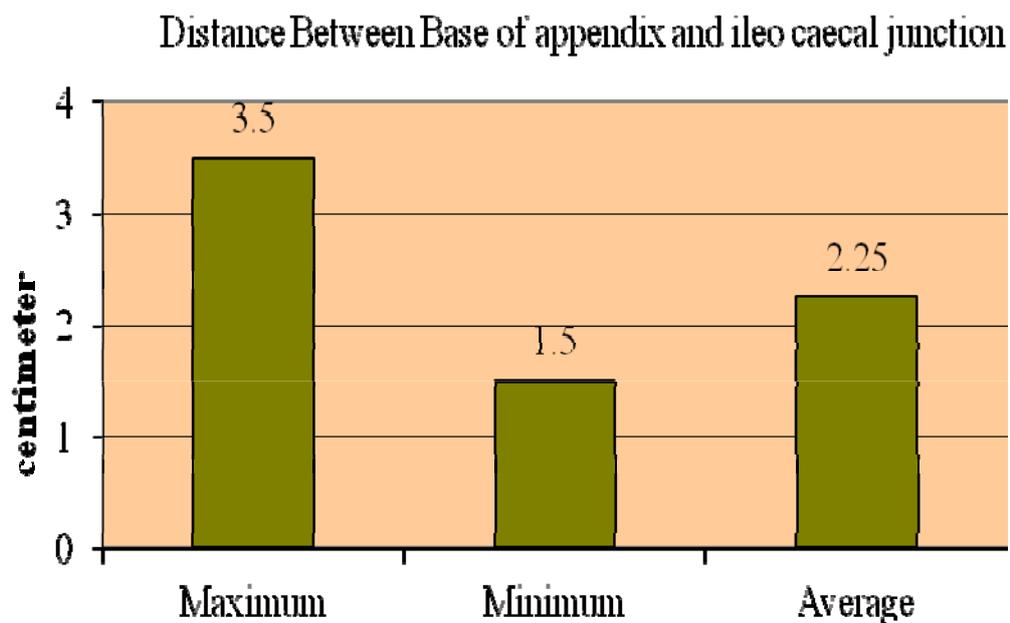
Table: 8

Distance between Base of the appendix and ileo caecal junction

Normal distance between the base of appendix and ileo caecal junction was 2.5cm to 3cm

| S.No | Distance Between Base of appendix and ileo caecal junction | |
|------|--|--------|
| 1. | Maximum | 3.5cm |
| 2. | Minimum | 1.5cm |
| 3. | Average | 2.25cm |

The distance between base of the appendix ranged between 1.5cms – 3.5cms. The Average distance was 2.25cm



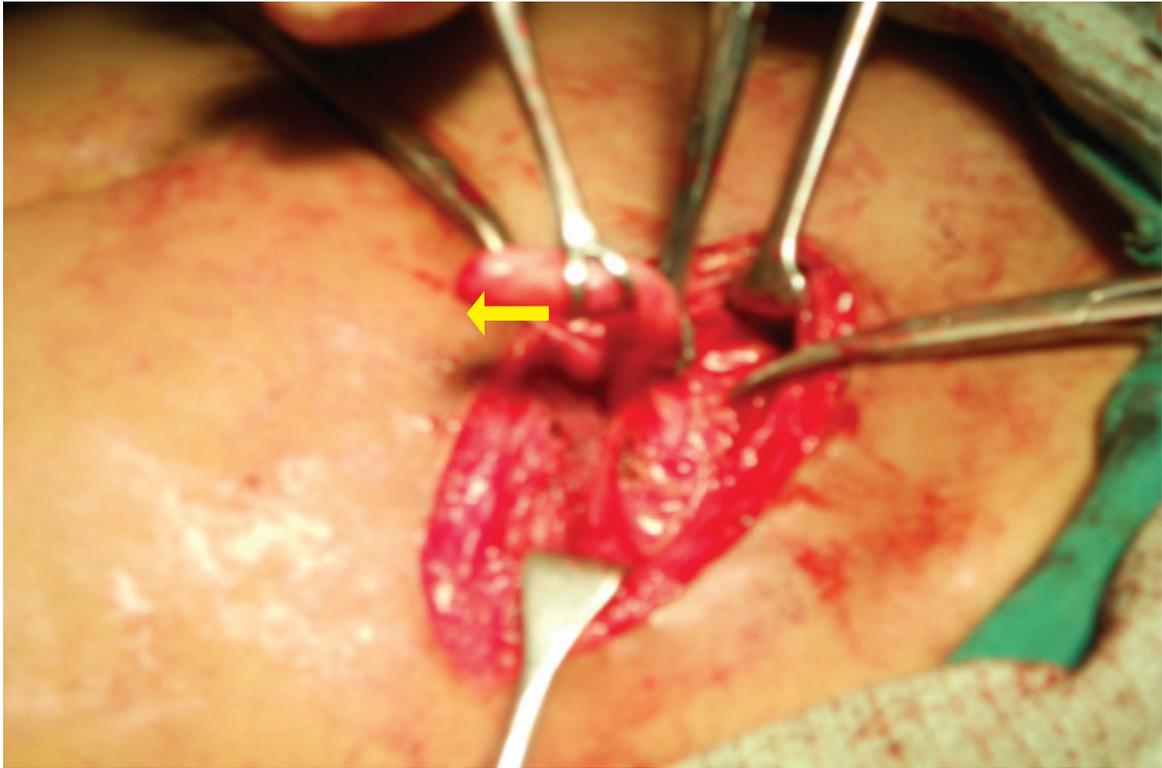


Photo - 21 Along Spino Umbilical Line

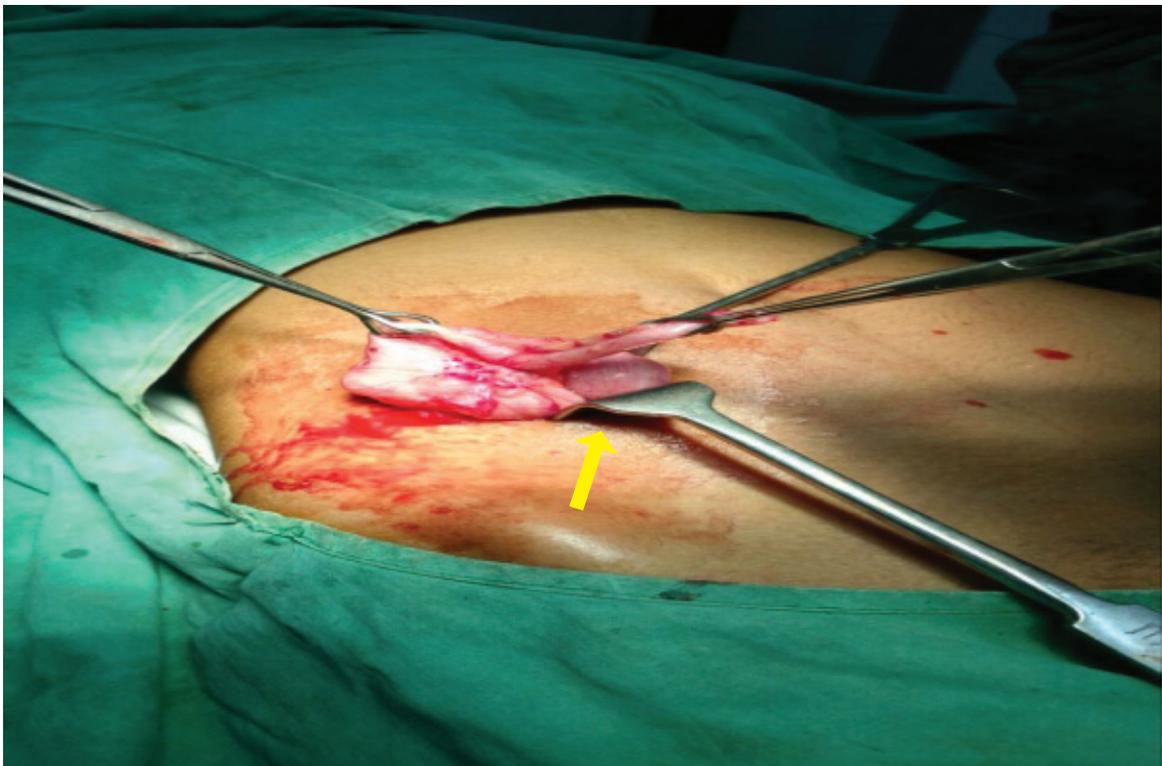


Photo - 22 Above Spino Umbilical Line

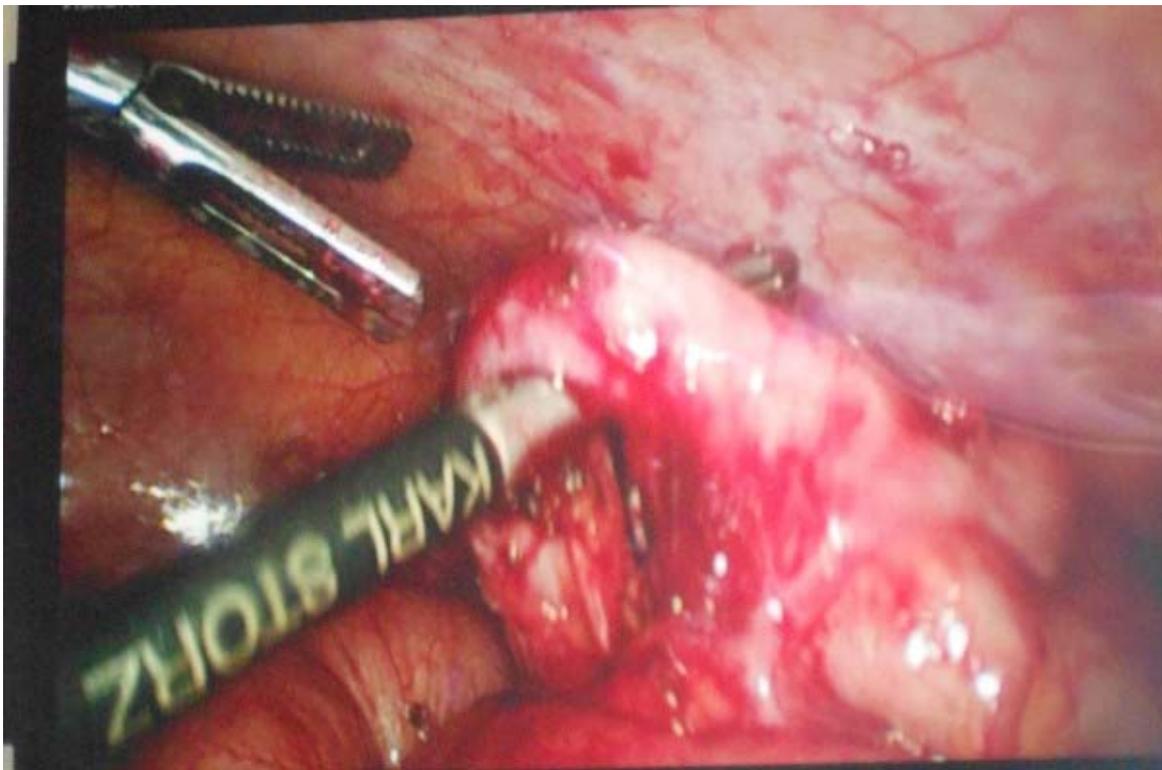


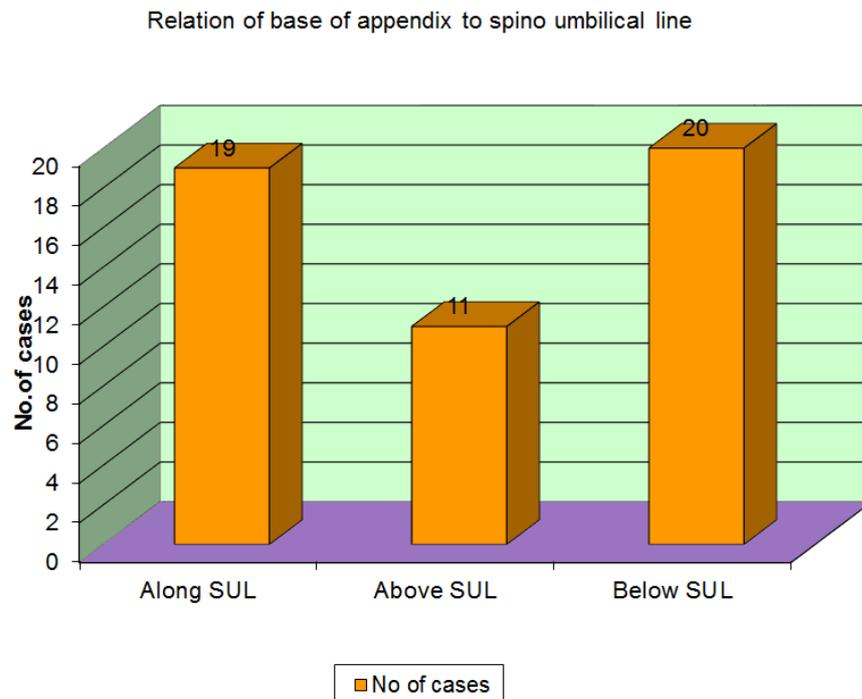
Photo - 23 Below & Medial to SUL

Table: 9

Relation of base of appendix to spino umbilical line

| S.No | Relation to Spino umbilical line | No of cases | % |
|------|----------------------------------|-------------|----|
| 1. | Along SUL | 19 | 38 |
| 2. | Above SUL | 11 | 22 |
| 3. | Below SUL | 20 | 40 |

In the present study, only 38% of appendix lying along the spinoumbilical line were corresponding to McBurney's point which is present at the junction of lateral 1/3 and medial 2/3 of spinoumbilical line. 22% of the appendix lie above and lateral to spinoumbilical line and 40% lie below and medial to spinoumbilical line In the present study 62% of appendix were not along the spinoumbilical line. This finding is clinically significant.



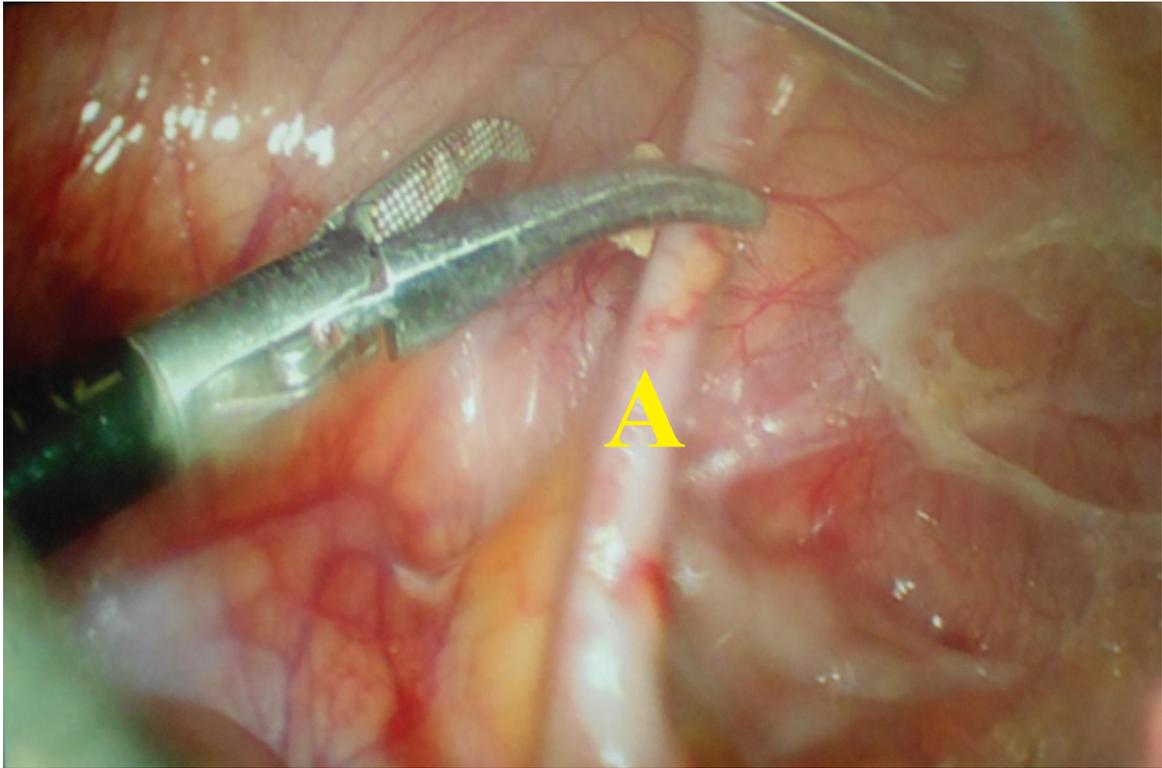


Photo - 26 Long Appendix 12cm



Photo - 27 Short Appendix 4 cm

Table: 10

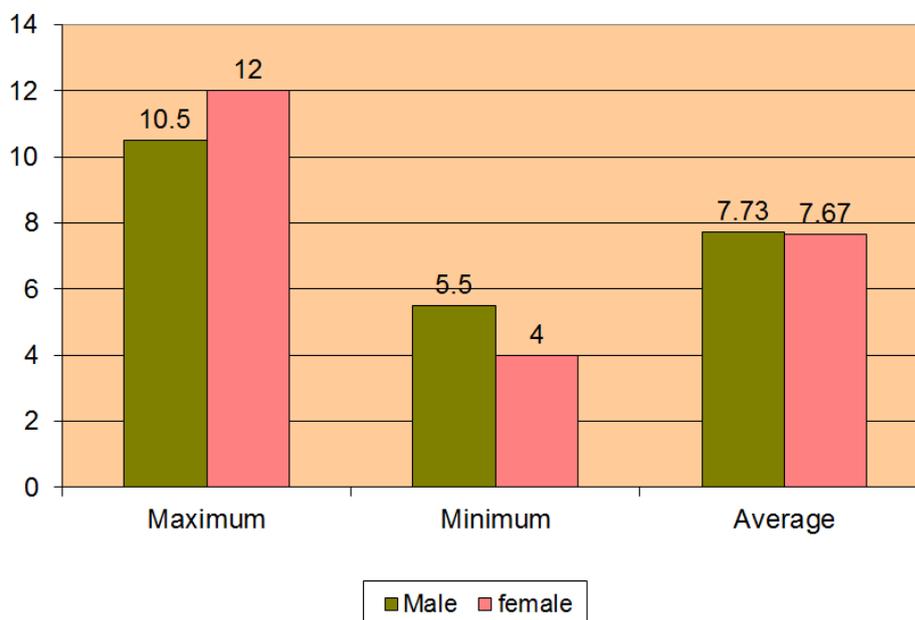
Length of the appendix according to sex

According to Gray⁴ the length of the appendix 6 -10cm

| S.No | Length | Males | Females | % |
|------|-----------|-------|---------|----|
| 1. | < 4cm | 0 | 1 | 2 |
| 2. | 4 – 7.9cm | 18 | 10 | 56 |
| 3. | 8 -11.9cm | 12 | 6 | 36 |
| 4. | > 12cm | 1 | 2 | 6 |

The length of the appendix ranged between 4cm to 12cm.

LENGTH OF THE APPENDIX IN CM



The shortest length of the appendix – 4cm

The longest length of the appendix – 12 cm

The Average length in males – 7.73cm

The Average length in females – 7.67cm

The Average length in adult – 7.68cm

Most of the appendices (56%) were between 4cm – 7.9cm in both males and females.

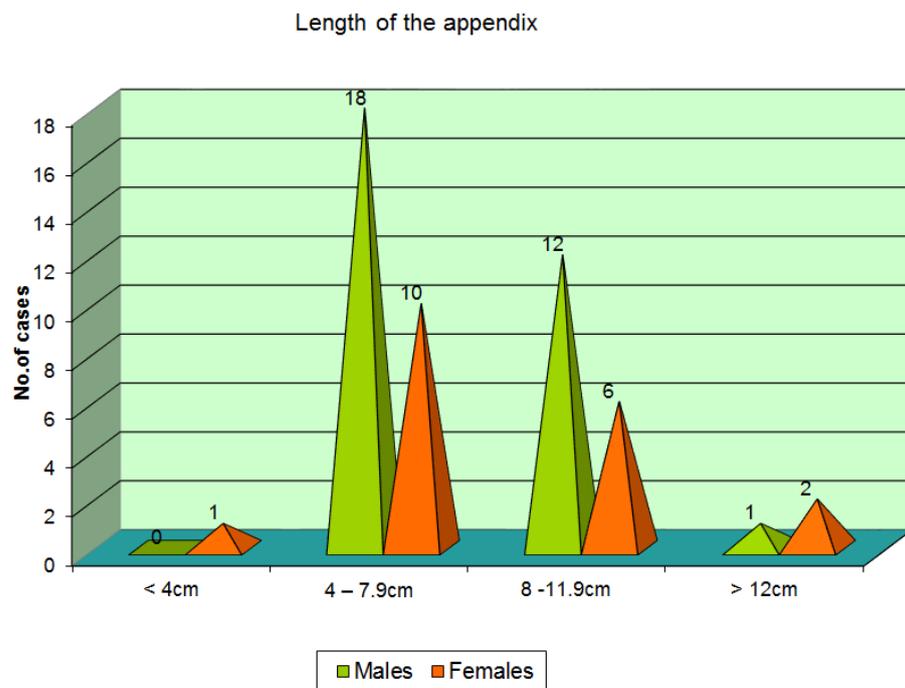


Table: 11

ASSOCIATION BETWEEN LENGTH OF THE APPENDIX AND AGE

| Age | <4cm | 4- 7.9cm | 8-11.9cm | 12cm | Total |
|----------|------|----------|----------|------|-------|
| 11-20yrs | - | 12 | 3 | - | 15 |
| 21-40yrs | - | 15 | 5 | 4 | 24 |
| 41-60yrs | - | 5 | 3 | - | 8 |
| >60yrs | - | 2 | 1 | - | 3 |
| Total | 0 | 34 | 12 | 4 | 50 |

Majority of the patients (34) have the length of 4 – 7.9cm. The maximum length of 12cm was present in 4 patients belonging to 21 to 40yrs.

ASSOCIATION BETWEEN LENGTH OF THE APPENDIX AND AGE

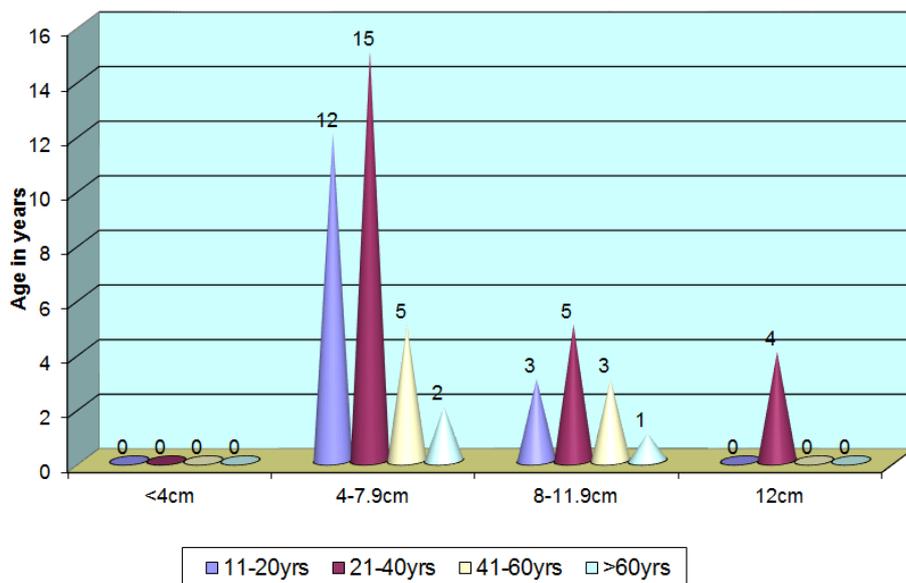




Photo - 28 Measurement of External Diameter

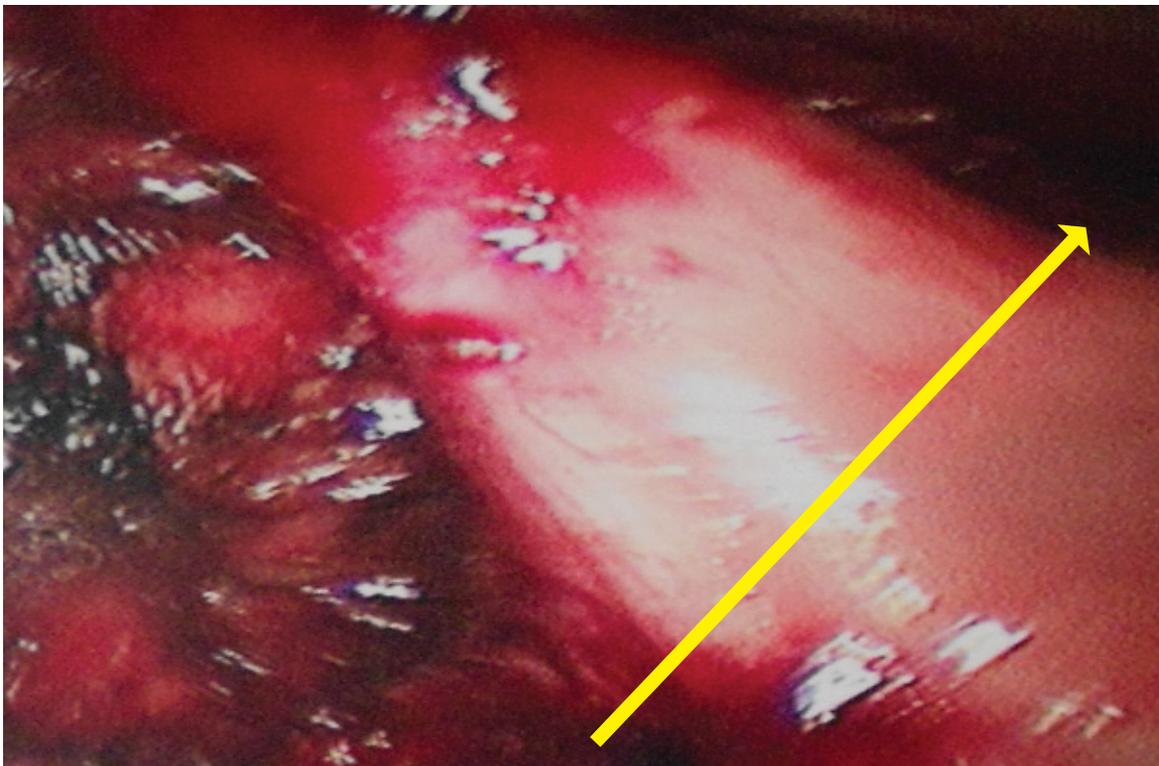


Photo - 29 Maximum External Diameter

Table: 12

External Diameter of the appendix

According to Schwartz (2015) the external diameter of the appendix varies between 3 to 8mm.

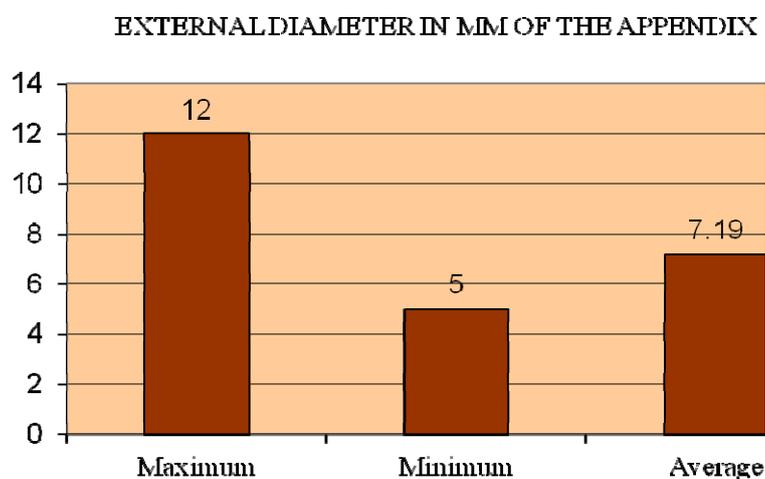
| S.No | External Diameter of the appendix | |
|-------------|--|--------|
| 1. | Maximum | 12mm |
| 2. | Minimum | 5mm |
| 3. | Average | 7.19mm |

In the present study, the maximum external diameter was 12mm and minimum external diameter was 5mm.

The average diameter in males - 7.45mm

The Average diameter in females – 6.87mm

The Ultrasonographic measurement of diameter of appendix more than 6 mm is clinically significant to rule out or confirm acute appendicitis.



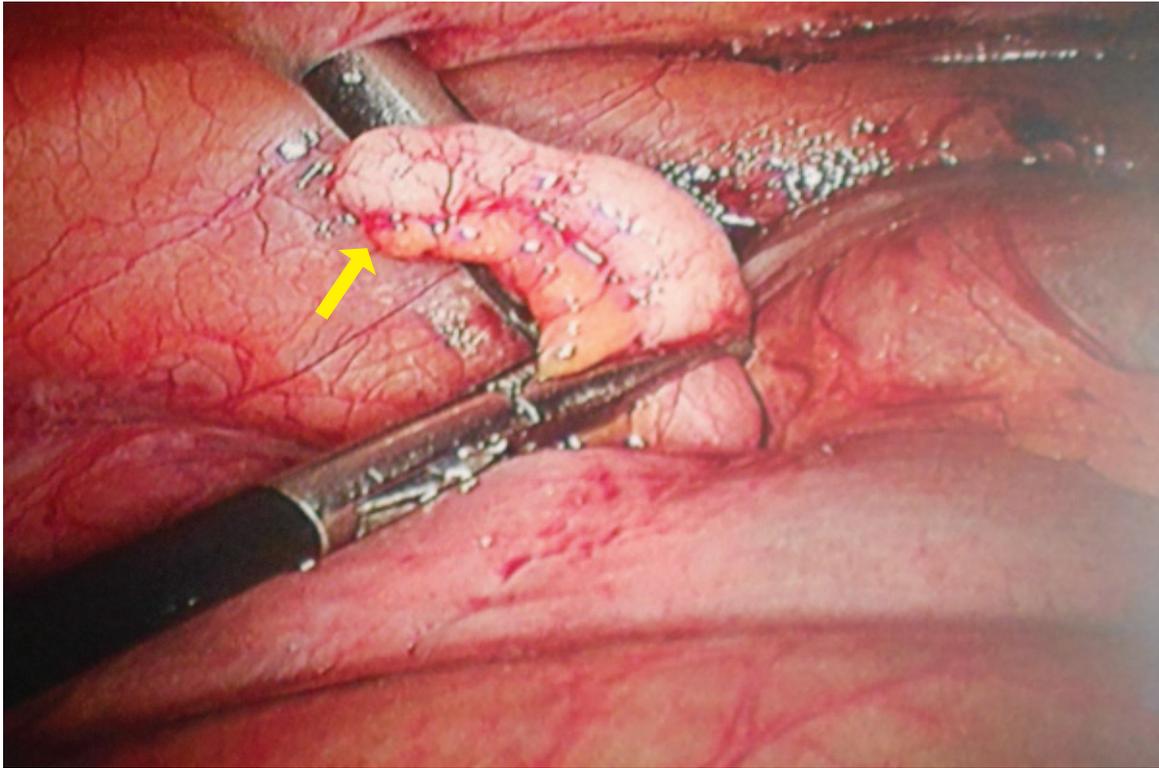


Photo - 30 Complete Mesoappendix

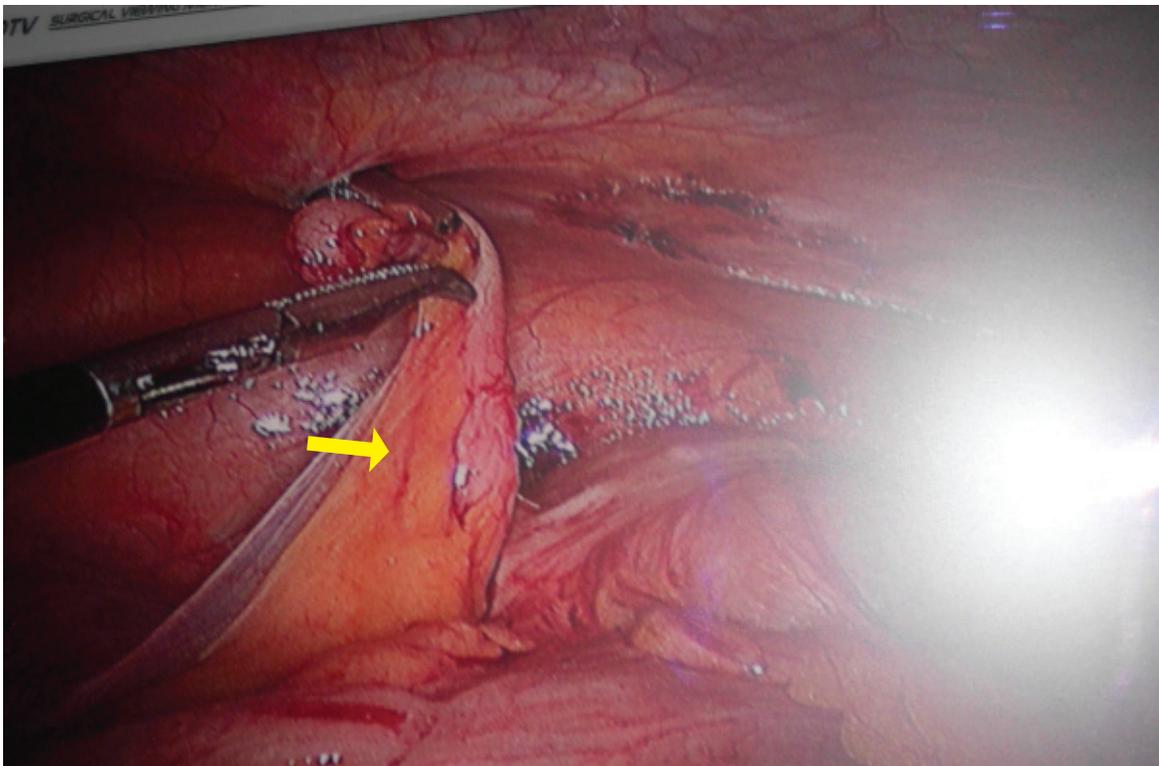


Photo - 31 Incomplete Mesoappendix

Table: 13

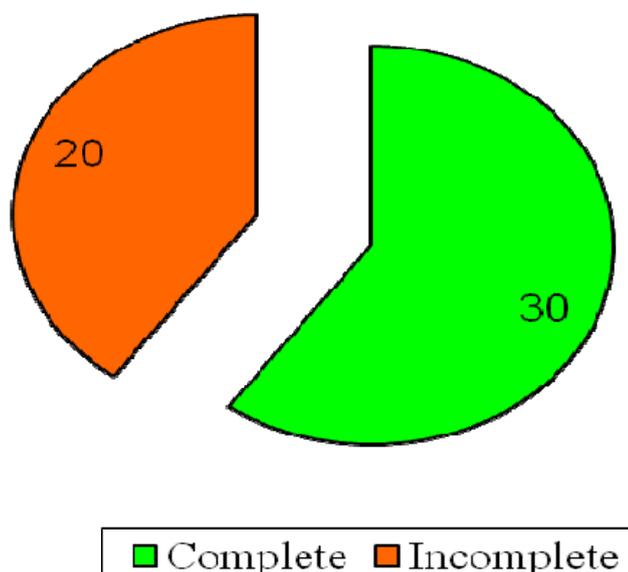
EXTENT OF MESOAPPENDIX

Mesoappendix usually extends upto the tip of the appendix

| S.No | Extent of Mesoappendix | No of cases | % |
|------|------------------------|-------------|----|
| 1. | Complete | 30 | 60 |
| 2. | Incomplete | 20 | 40 |

In the present study, mesoappendix was complete in 60% and incomplete in 40% of cases

EXTENT OF MESOPAPPENDIX



Incomplete mesoappendix reduces the blood supply to the tip leads to early perforation.

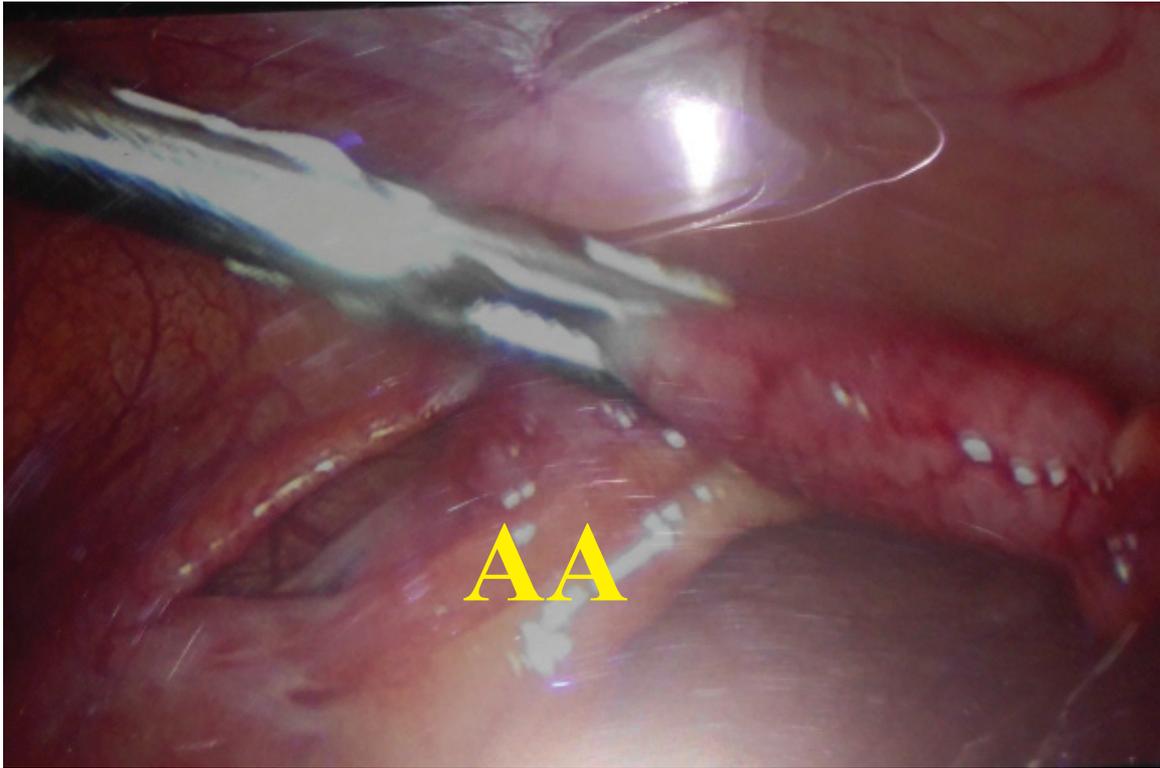


Photo - 32 Single Appendicular Artery

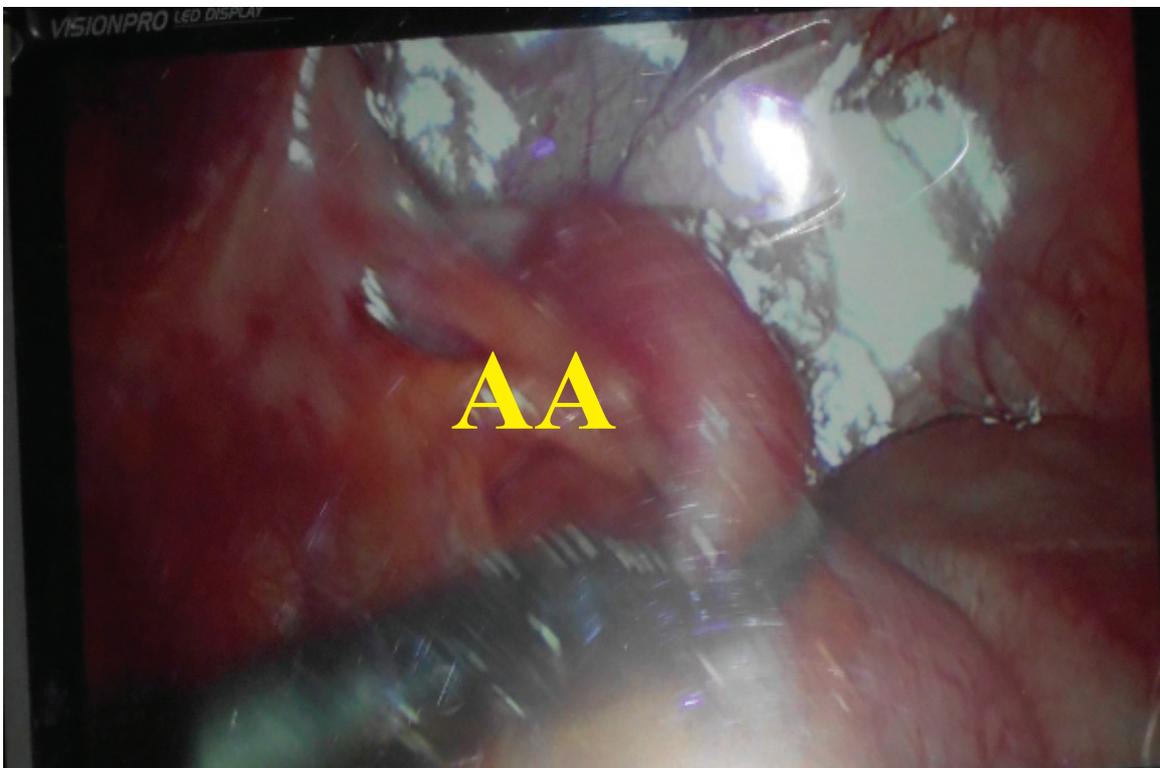


Photo - 33 Double Appendicular Artery

Table: 14

APPENDICULAR ARTERY

Normally appendicular artery takes origin from inferior division of ileocolic artery. There may be accessory AA also present.

| S.No | Number of appendicular artery | No of cases | % |
|------|-------------------------------|-------------|----|
| 1. | Single | 49 | 98 |
| 2. | More than one | 1 | 2 |
| 3. | Accessory AA | - | - |

In the present study single appendicular artery was present in 98% of cases. Presence of accessory AA is important for surgeons during laparoscopic surgeries.

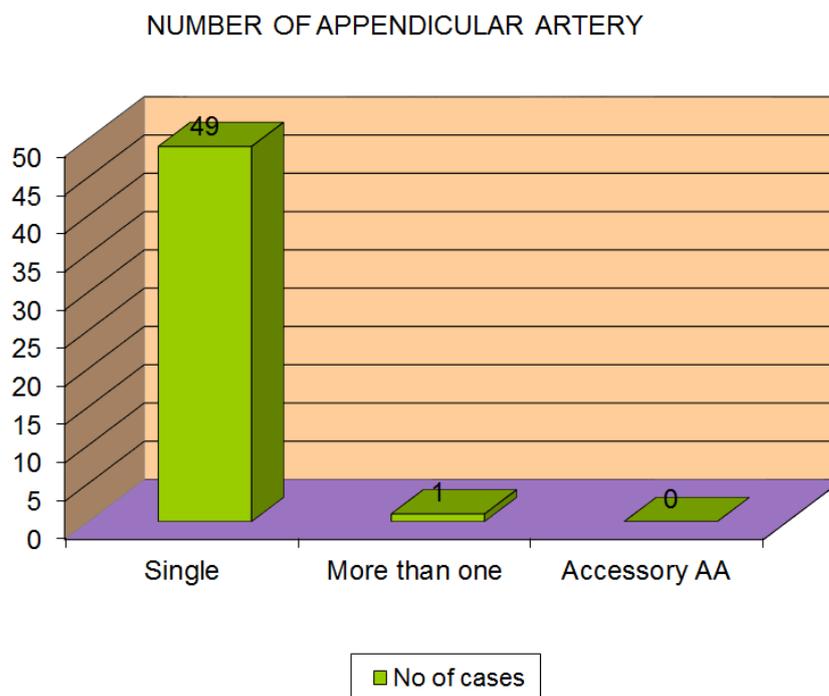




Photo - 34 Duplication of Appendix

ANOMALY OF THE APPENDIX

In the present study, one bifid appendix was present in the 27 years old male. This bifid appendix symmetrically placed on either side of ileo caecal valve in the right iliac fossa. The length of the both appendix was 8cm and external diameter was 6mm. Its tip occupies 11o'clock position and in paracaecal position. Complete mesoappendix was seen with two appendicular arteries arising from ileo colic artery. It belongs to type B1 according to modified cave wall bridge classification.

DISCUSSION

DISCUSSION

Table: 15

Location of the appendix

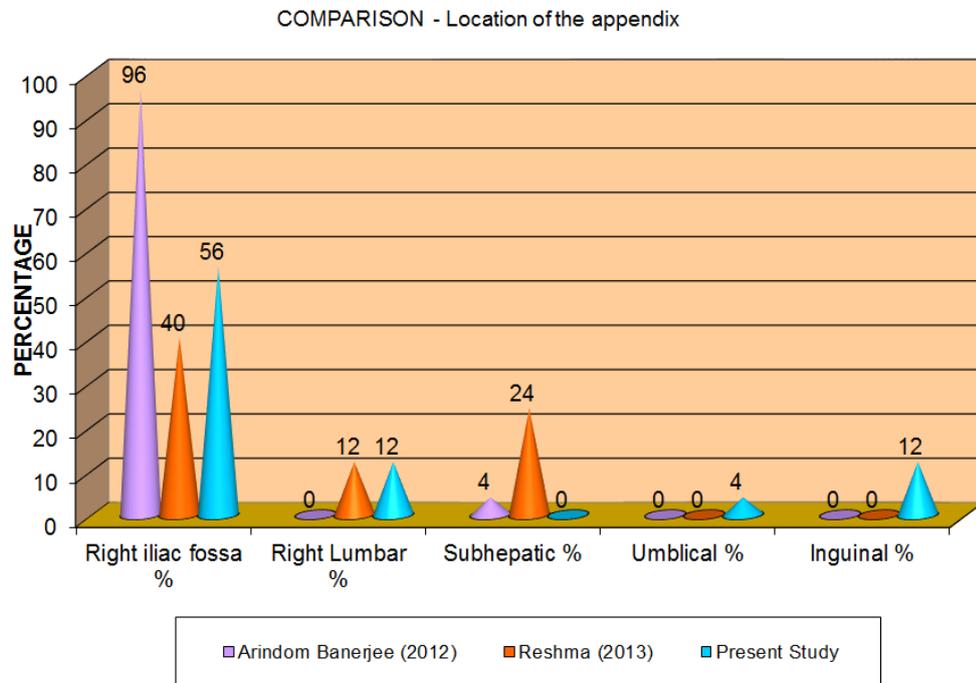
| S.No | Name of the study | Right iliac fossa % | Right Lumbar % | Subhepatic % | Umbilical % | Inguinal % |
|------|-------------------------|---------------------|----------------|--------------|-------------|------------|
| 1. | Arindom Banerjee (2012) | 96 | - | 4 | - | - |
| 2. | Reshma (2013) | 40 | 20 | 40 | - | - |
| 3. | Present Study | 56 | 12 | 6 | 4 | 12 |

In Majority of the cases the appendix was located in right iliac fossa. According to Arindom Banerjee who studied 25 cases, found appendix in RIF in 96% and Subcaecal in 4%

Reshma et al stated in her study of 60 fetuses, higher incidence of sub-hepatic position in less than 30 weeks and right iliac fossa position in more than 30 weeks and an equal incidence of right lumbar location.

There was also higher incidence of sub-hepatic position in males, right iliac fossa position in females and equal incidence of right lumbar position in both sexes.

In Karim's study (1991) the appendix was in pelvic region (54%), umbilical (15%) right iliac (20%) and right inguinal region (11%)



In the present study, the vermiform appendix occupied right iliac fossa 56%, right lumbar region 12%, umbilical 4% and inguinal 12%. The present study was comparable with previous studies.

Table: 16

CLOCK POSITION OF THE APPENDIX

| S.No | Name of the study | 2 o' clock position | 5 o' | 6 o' | 11 o' | 12 o' |
|------|-------------------|---------------------|------|------|-------|-------|
| 1. | Reshma (2013) | 16% | 15% | 45% | - | 24% |
| 2. | Present study | 14% | 24% | 6% | 14% | 42% |

On comparison with reshma et al, the incidence of 2'o clock and 5'o clock coincided with present study. In the present study, 12'o clock position (42%) is higher than 5 'o clock position (24%) and 6'o clock position (6%).

Arindom Banerjee (2012) observed that 12'o clock position was higher 68% followed by 3'o clock position 16% 2'o clock position 8% and 6'o clock position 4% The present study comparable with previous authors.

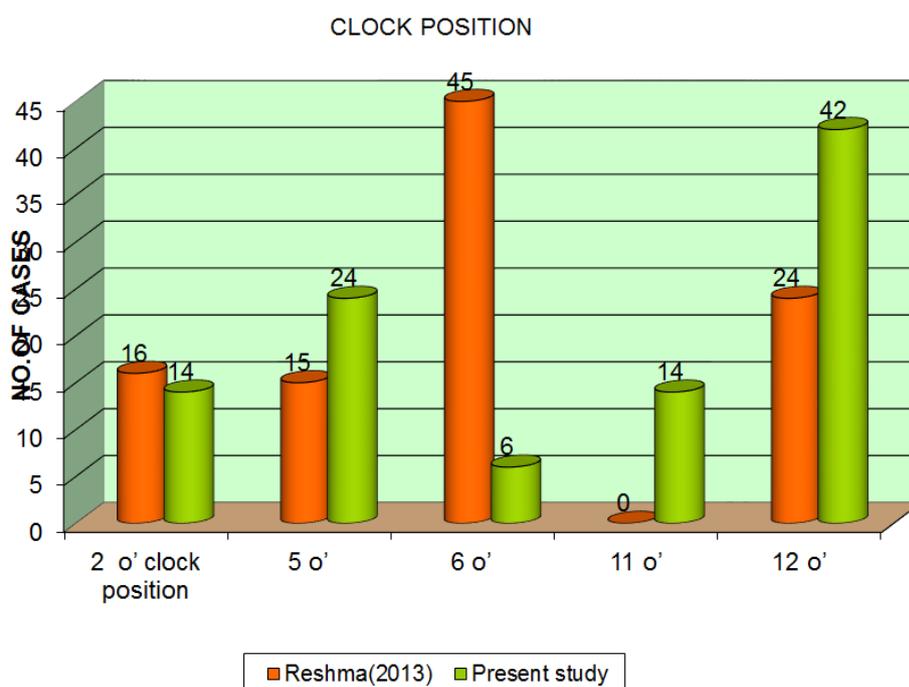


Table: 17

DIRECTION OF TIP

| S.No | Name of study | Upwards % | Oblique % | Downwards % |
|------|---------------|-----------|-----------|-------------|
| 1. | Reshma (2013) | 40 | 13 | 47 |
| 2. | Present study | 58 | 12 | 30 |

Reshma found that downwards direction (47%) was higher than oblique and upward direction.

In the present study, the upward direction tip of the appendix was 58% which was higher than downward direction 30% and oblique direction 12%. The present study was comparable with other studies.

Direction of tip is clinically important while diagnosing acute appendicitis and signs and symptoms varies according to the direction of tip.

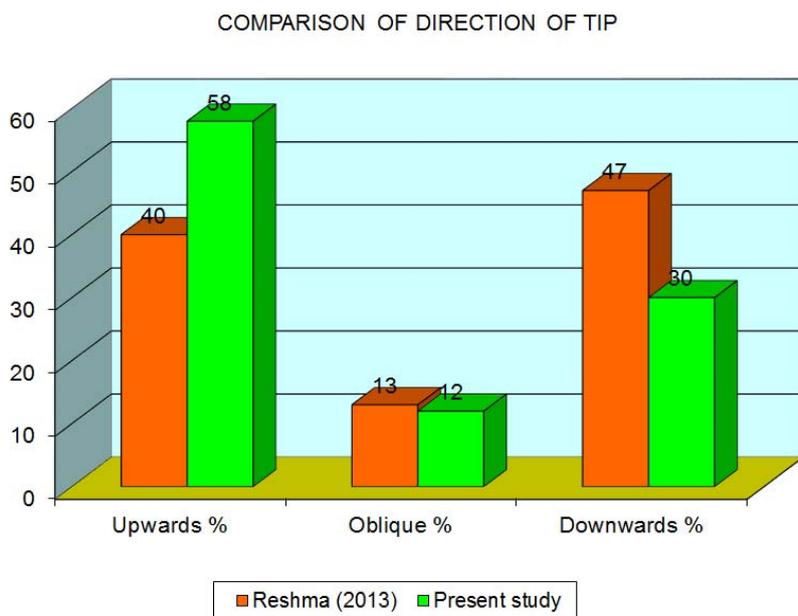


Table: 18

POSITION OF BASE IN RELATION TO CAECAL WALL

| S.No | Name of study | Anterior wall % | Posterior wall% | Lower pole% | Lateral wall% | Medial wall% |
|------|---------------|-----------------|-----------------|-------------|---------------|--------------|
| 1. | Reshma (2013) | 7 | 58 | 29 | 3 | 3 |
| 2. | Present study | 8 | 54 | 30 | 8 | |

The position of the base of the appendix according to caecal wall was higher in posterior wall than anterior wall and lower pole in the Reshma study.

Delic (2002) reported position of base at posterior wall 48%, anterior wall 10%, lower pole 32% and lateral wall 10. Similarly in present study the incidence of posterior wall 58% which coincided with previous studies.

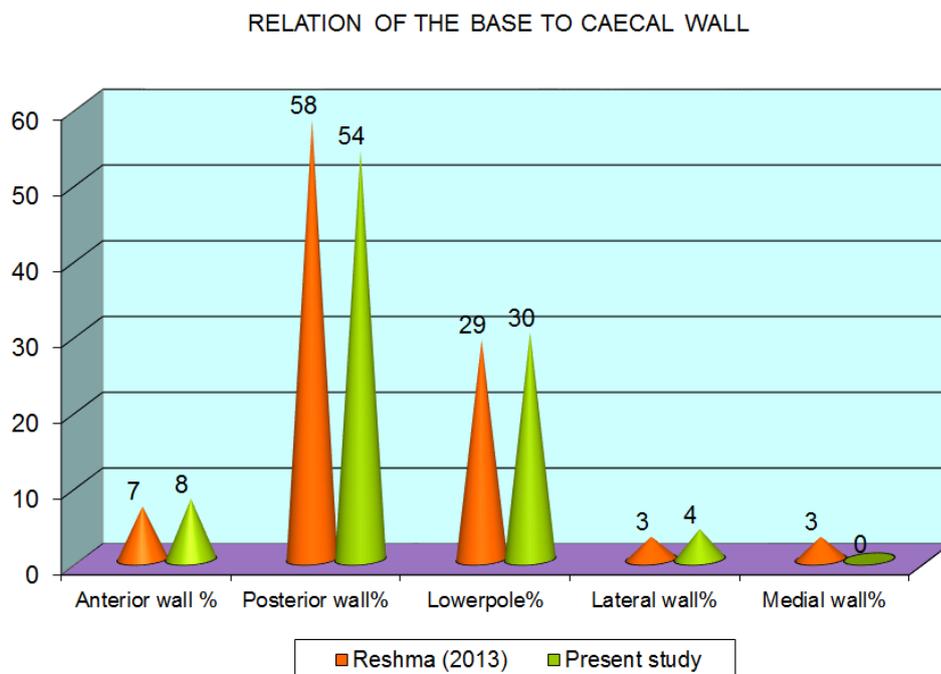


Table: 19
Position of the appendix

| S. No | Name of the study | Retro caecal % | Pelvic % | Pre ileal % | Post ileal % | Para caecal % | Sub caecal % | Ectopic /Others % |
|--------------|--------------------------|-----------------------|-----------------|--------------------|---------------------|----------------------|---------------------|--------------------------|
| 1. | Wakeley 1933 | 65.28 | 31.01 | 1 | 0.4 | | 2.26 | 0.05 |
| 2. | Ajmani 1983 | 68 | 20 | 1 | 10 | - | - | 1 |
| 3. | Paul 2009 | 65 | 31.7 | - | 3.3 | - | - | |
| 4. | Arindom Banerjee 2012 | 68 | 16 | 8 | - | 4 | - | 4 |
| 5. | Setty 2013 | 50 | 15 | 5 | 10 | - | 10 | 10 |
| 6. | Sanjay kumarsinha 2014 | 62 | 22 | - | - | 8 | 2 | 6 |
| 7. | Manisha 2013 | 55.5 | 23.5 | - | 9 | 5 | 6.5 | 0.5 |
| 8. | DasNk 2014 | 51.14 | 42.29 | 0.51 | 0.8 | - | 5.23 | 0.03 |
| 9. | Uma Maheswar rao 2015 | 66 | 26 | 2 | 2 | - | 4 | |
| 10. | Present study | 50 | 24 | 10 | 4 | 6 | 6 | |

According to Gray, the tip occupies most commonly retrocaecal or retrocolic position and then pelvic position. Other positions like subcaecal, pre

ileal or post ileal occurs especially when a long appendicular artery allows greater mobility.

In most of the studies by previous authors like wakeley (1933) Ajmani (1983), Paul (2009), Arindom Banerjee (2012), Setty (2013), Sinha (2014), Manisha (2013), Das NK (2014), Uma maheswar rao (2015), salwe (2014), Philip Mwachaka (2013) and desouza (2015) most common position was retrocaecal and next position was pelvic variety.

But in studies done by Golalipour (2003), Geethanjali (2011), Tolfigui (2013), Ghorboni (2014) and Kasukorthy (2016), the most common position was pelvic variety.

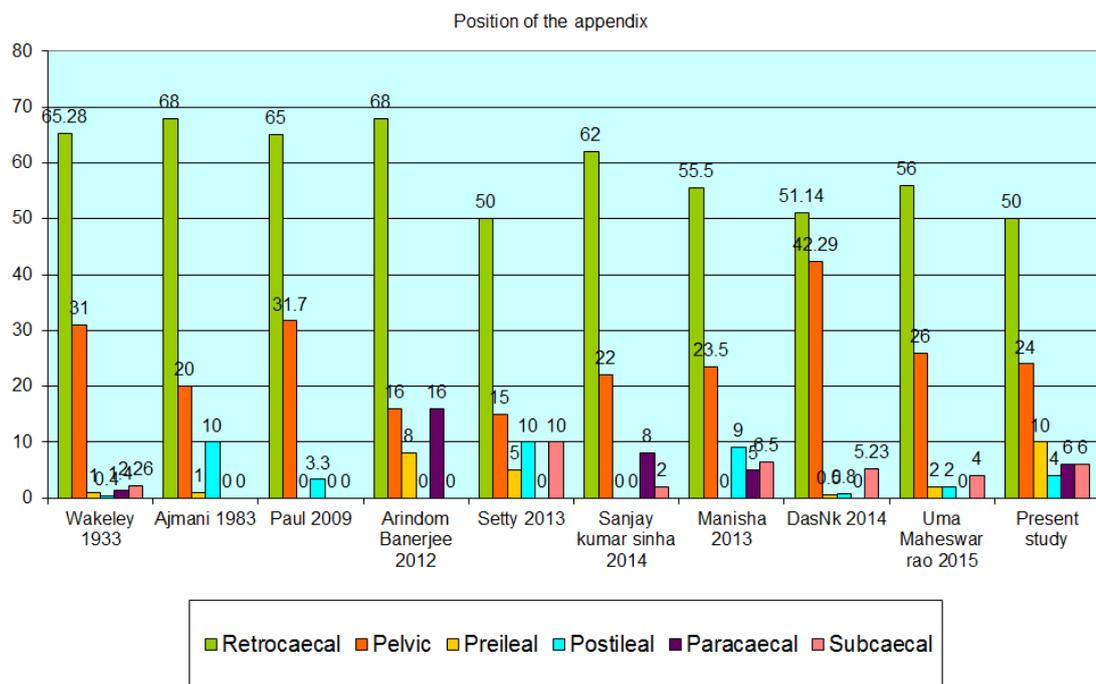
In Reshma study (2013) in human fetuses majority of appendices are in postileal position in both sexes. This may be due to the differential growth at the pre arterial and post arterial segments of midgutloop that form the jejunum, ileum and large intestine respectively.

According to Buschard K¹¹⁴, the position of the appendix was closely related to the development of caecum. Gender, age, body, postural changes and different degrees of caecal rotation had not been described as determinants of the position of the appendix. Although the location of the appendix was initially under liver, after 10th week of intrauterine life, the fetal intestines return to the abdominal cavity, causing the caecum to gradually descends into right iliac fossa, with counter clock wise twisting motion around its longitudinal axis. During this caecal descent, the appendix goes behind caecum and remain fixed in this retrocaecal posture. During embryonic

development further growth of right wall of caecum or stronger fusion of caecum and colon might shift the base of appendix towards ileo caecal junction leads to pre-ileal and postileal position.

The presence of pelvic position had been associated with presence of genito mesenteric fold which runs vertically downwards from terminal ileum to deep inguinal ring (or) right ovary.

Therefore in view of extended mobility of the appendix and caecal migration, it was concluded that appendix may modify its final positioning and may occupy various position in our body.



In the present study the most common position was retrocaecal (50%) then, pelvic (24%), preileal (10%), post ileal (4%) paracaecal 6% and subcaecal 6% coincides with these findings, the present study was comparable with previous reports and the findings of retrocaecal position was within the range (18 -65%) reported by other researchers.

Table: 20

DISTANCE BETWEEN BASE AND ILEOCAECAL JUNCTION

| S.No | Name of study | Range | Average |
|------|------------------|-----------------------------------|---------|
| 1. | Reshma(2013) | 16-40mm | 24.2mm |
| 2. | Nilesh(2014) | Male – 2.63 cm Female – 2.31cm | 2.8cm |
| 3. | Kasukurthy(2016) | 0.42 -3cm | 2.8cm |
| 4. | Present study | 1.5 to 3.5cm | 2.25cm |

In the present study, the distance of base of the appendix ranged from 1.5cm to 3.5cm. The minimum distance was 1.5cm and maximum distance was 3.5cm.

The average distance of base from ileocaecal junction was 2.25cm which coincided with others study.

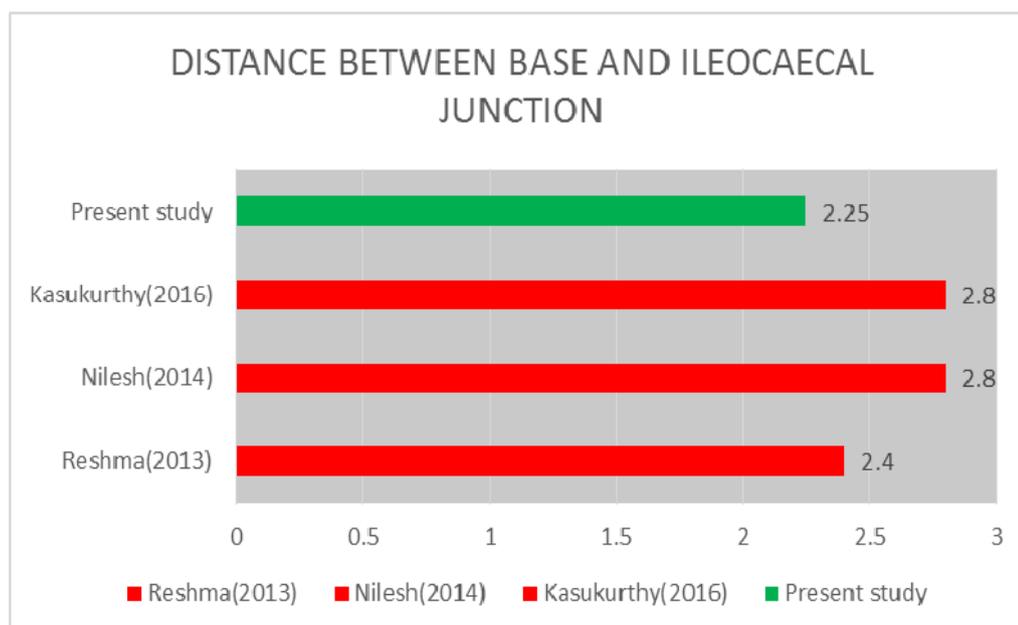


Table: 21

RELATION OF BASE TO SPINO UMBILICAL LINE

| S.No | Name of Author | Along SUL% | Above SUL % | Below SUL% |
|-------------|-----------------------|-----------------------|------------------------|-----------------------|
| 1. | Philip Mwachaka | 52.1 | 29.2 | 18.8 |
| 2. | Present study | 38 | 22 | 40 |

According to snell¹¹⁵, the base of appendix is situated at the lateral one third and medial two third of the line joining the anterior superior iliac spine to the umbilicus (McBurney's point)

In a study of Philip mwachaka spinoumbilical line was measured and Mc Burney's point was taken at the proximal two – third of the spinoumbilical line. The relationship of Mc Burney's point and base of appendix was classified as cephalad, caudad or along spinoumbilical line.

The base of the appendix was located along spinoumbilical line in 25 cases (52%), below and medial to the line in 9 cases (15%) and above and lateral in 14 cases (29%).

In half of the cases, the base of the appendix was not corresponding to Mc Burney's point. Thus most appendixes were located approximately at midpoint at spinoumbilical line and not exactly at Mc Burney's point.

Narayn singh (2002) reported the base of appendix was 67 % cephalic, 32% caudal and 1% corresponding to McBurneys point.

In the Present Study, the base of appendix were along the spinoumbilical line only in 19 cases (38%). In remaining cases, it was below and medial in 20 cases (40%) and above and lateral in 11 cases (22%). The results of the study coincided with Philip Mwachaka study.

Majority of appendixes 62% (More than 50%) lie either above or below the spinoumbilical line and not corresponding to Mc Burney's point as discussed in previous reports. This finding is clinically significant for operation surgeons.

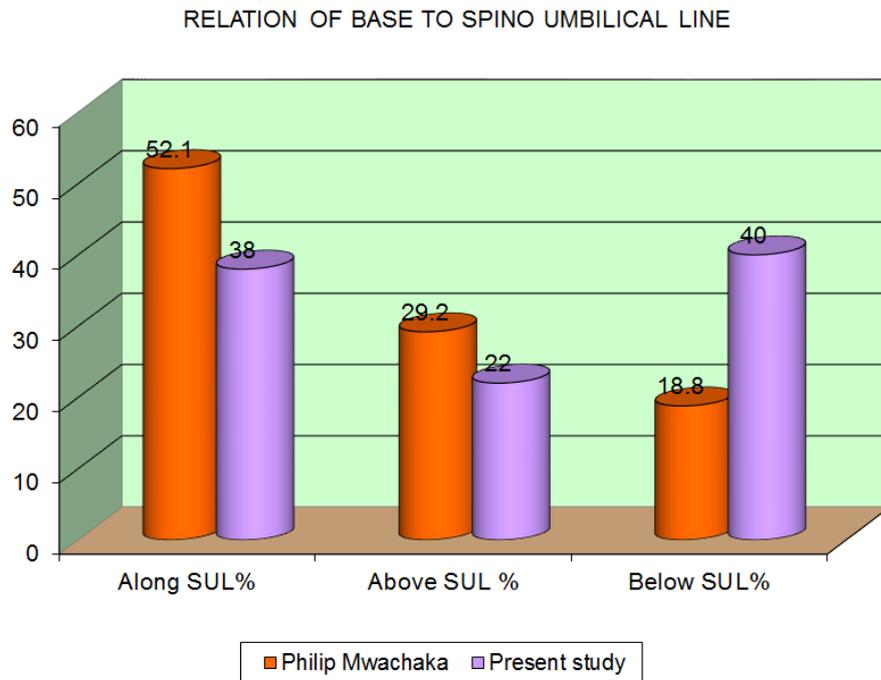
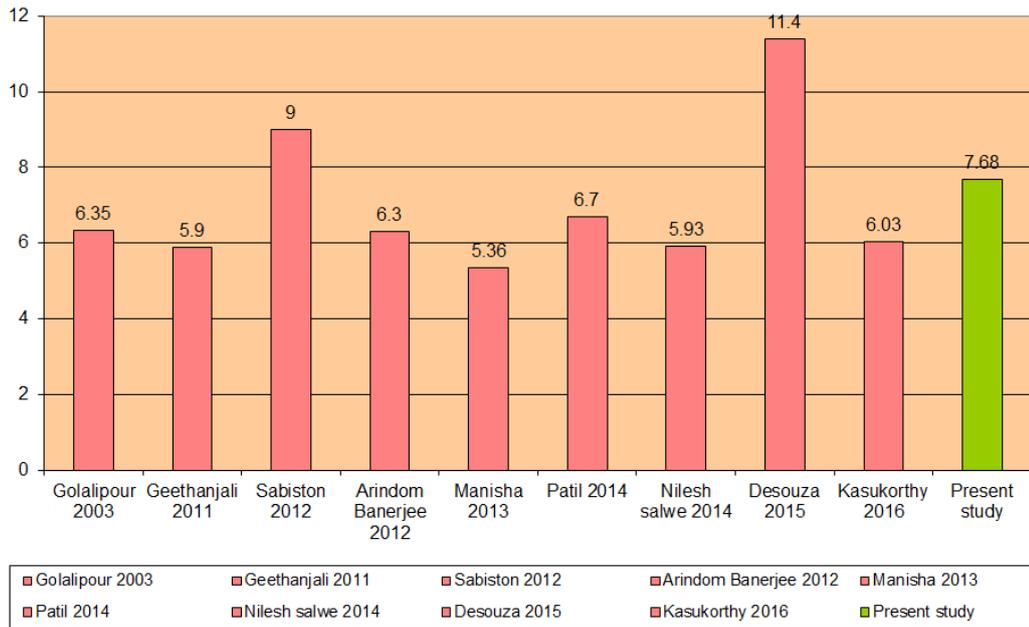


Table: 22
Length of appendix

| S.No | Length | Range cm | Average cm |
|------|-----------------------|----------|---------------|
| 1. | Golalipour 2003 | | 6.61cm/6.06cm |
| 2. | Geethanjali 2011 | | 6.47/5.34 |
| 3. | Sabiston 2012 | 2-20 | 9 |
| 4. | Arindom Banerjee 2012 | 4-13 | 6.3 |
| 5. | Manisha 2013 | | M 5.56 F 5.16 |
| 6. | Patil 2014 | | M 7.5 F 6 |
| 7. | Nilesh salwe 2014 | | 5.93 |
| 8. | Desouza 2015 | 1-20 | 11.4 |
| 9. | Kasukorthy 2016 | | 6.03 |
| 0. | Present study | 4-12 | 7.68 |

According to Sabiston the length of the appendix varies from 2cm – 20cm and average length was 9cm. According to authors, Golalipour, Geethanjali, Arindom Banerjee, Manisha, Patil, Nilesh salwe and kasukurthy length of appendix ranged between 5 -6 cm. In a study done by Desouza at salvador brazil, the average length was higher about 11.4cm. Length of appendix about 9 – 15 cm was used as a conduit in bladder and biliary tract surgeries in children.

COMPARISON - LENGTH IN CM



In the present study, the length ranged between 4 to 12 cm. The maximum length was 12 cm in females and 10.5 cm in males. The minimum length was 7.4 cm in females and 5 cm in males. The average length was 7.68 cm comparable with other studies.

Table: 23

EXTERNAL DIAMETER OF THE APPENDIX

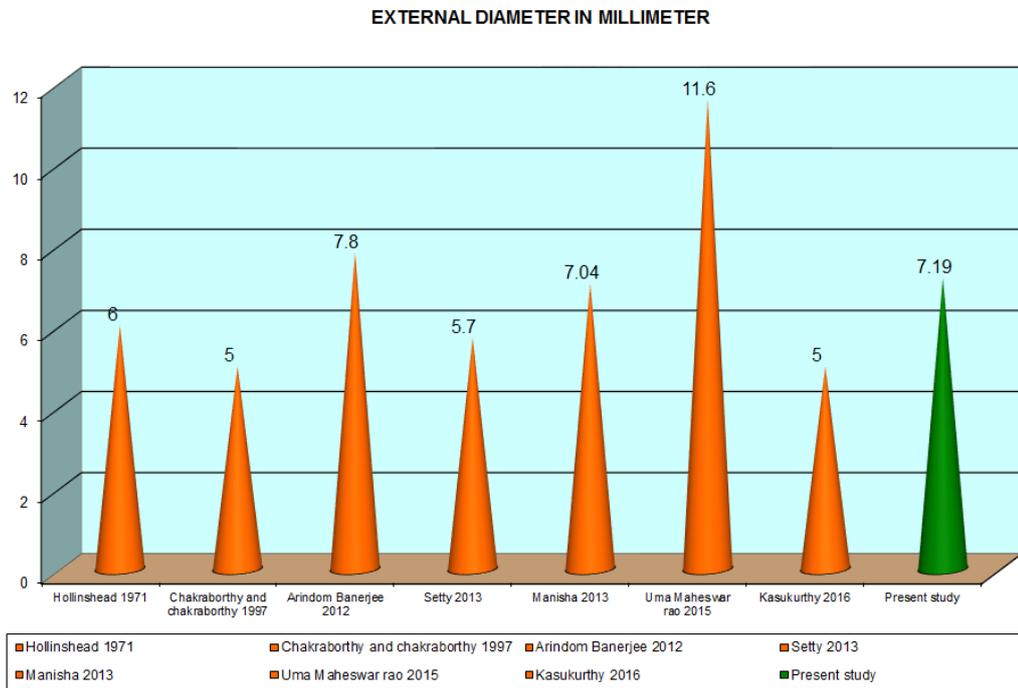
| S.No | Name of Author | Average mm |
|-------------|----------------------------------|--------------------|
| 1. | Hollinshead 1971 | 6 |
| 2. | Chakraborty and chakraborty 1997 | 5 |
| 3. | Arindom Banerjee 2012 | 7.8 |
| 4. | Setty 2013 | M 6mm F 5.42 |
| 5. | Manisha 2013 | 7.045 |
| 6. | Uma Maheswar rao 2015 | M 12.42 F 10.80 |
| 7. | Kasukurthy 2016 | 5 |
| 8. | Present study | 7.19 |

The average external diameter at the base of appendix was 5 – 6 mm described by Hollin shead, chakraborty N.C D Lochart cunningham, setty and kasukorthy.

The external diameter ranged about 7 mm in a study by Manisha and Arindom Banerjee. But diameter was very high in Uma Maheswar rao's study more than > 10mm. Increased thickness may be related to their dietary habits

In the present study, external diameter in male ranged between 5mm – 10mm and the average diameter was 7.45mm. In females, external

diameter ranged between 5 – 12 mm and the average was 6.87mm. The results of this study coincided with study of Setty, Manisha and Banerjee.



The ultrasonography measurement of outer diameter of appendix more than 6mm is sign of acute appendicitis, it is clinically significant to confirm or exclude acute appendicitis.. Retten Bachar stated diameter more than 6mm helps to confirm acute appendicitis with sensitivity 100% and accuracy 79 %

Table: 23**EXTENT OF MESOAPPENDIX**

| S.NO | NAME OF STUDY | EXTENT | | |
|------|-----------------------|------------|--------------|---|
| | | COMPLETE % | INCOMPLETE % | |
| 1. | Golalipour 2003 | 34.2 | 65.8 | |
| 2. | Rehman 2009 | 24 | 76 | |
| 3. | Geethanjali 2011 | 69.23 | 30.77 | |
| 4. | Tolfigui 2013 | 79.5 | 20.5 | |
| 5. | Sinha 2014 | Male | 95 | 5 |
| | | female | 92 | 8 |
| 6. | Ghorbani 2014 | 79.5 | 20.5 | |
| 7. | Janardhana rao 2014 | 16 | 84 | |
| 8. | Uma Maheswar rao 2015 | 34 | 66 | |
| 9. | Kasukorthy 2016 | 57 | 28 | |
| 10. | Present study | 60 | 40 | |

According to Bailey & love (2013) the mesoappendix which extends from terminal ileum to vermiform appendix subjects to great variation. Sometimes even the whole extent of appendix was devoid of mesoappendix. The appendicular artery present in the mesoappendix, which is an end artery may not reach the tip leading to ischaemic necrosis and subsequent gangrenous appendicitis. According to Dutta and gray, the mesoappendix is up to the tip of appendix whereas per Hollinshead and last, the mesoappendix was of variable length.

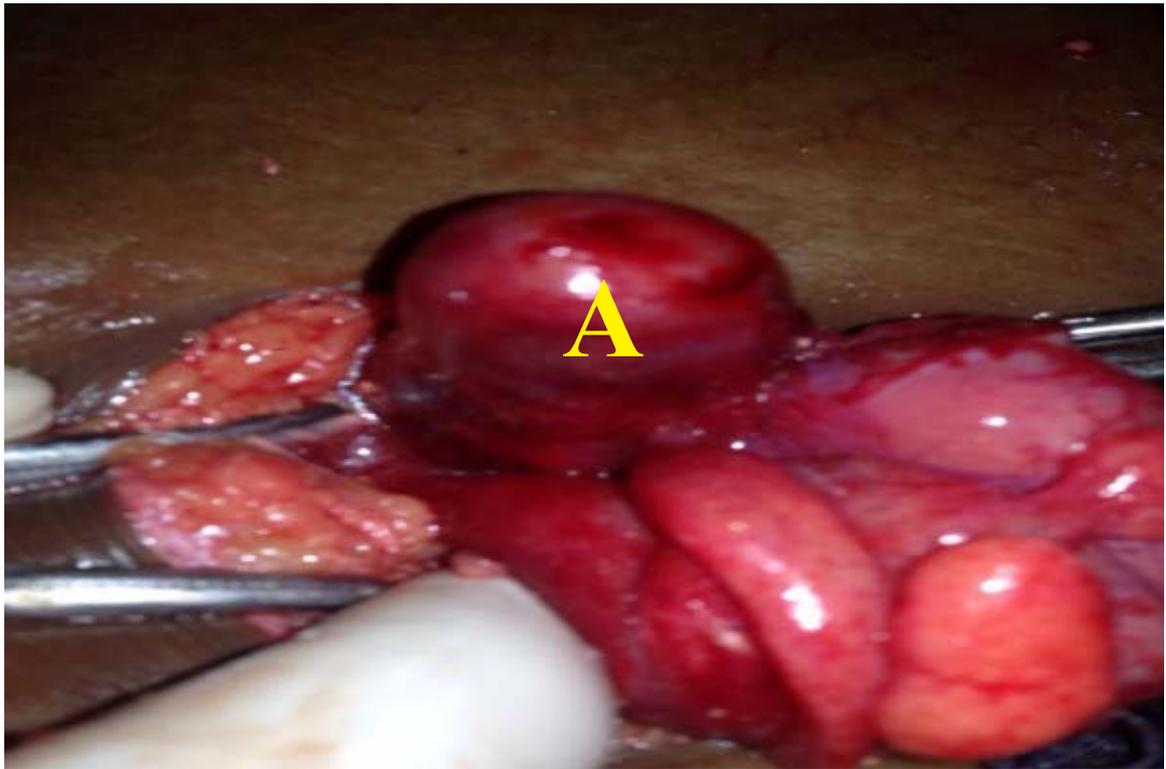
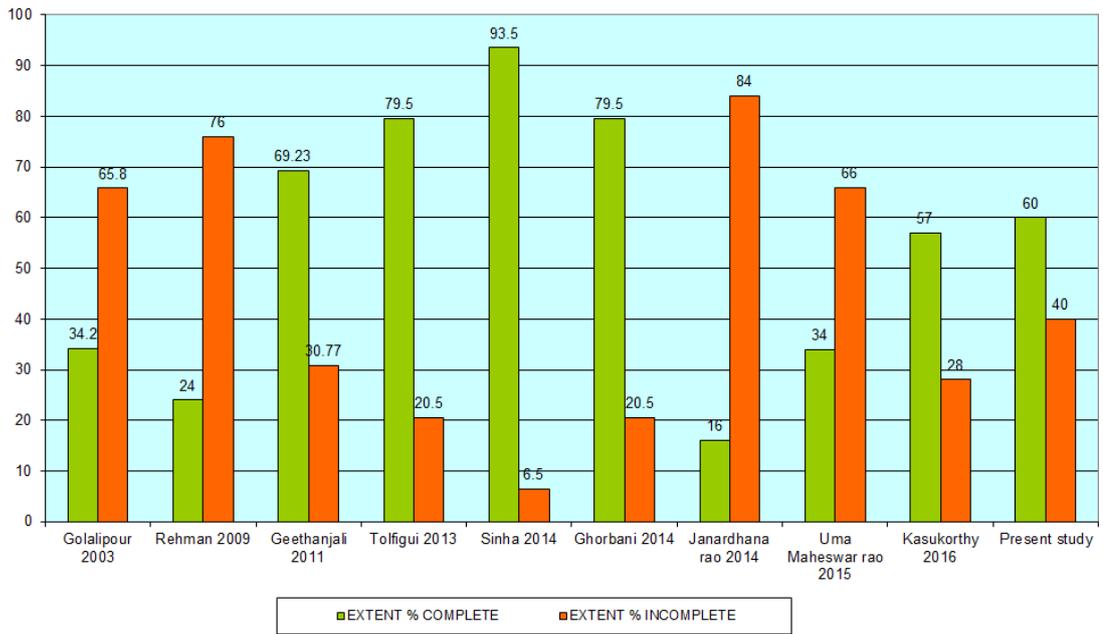


Photo - 35 Gangrenous Appendix

EXTENT OF MESOAPPENDIX



According to Schwartz, the mesoappendix extends almost to the tip of appendix (or) failure of the mesoappendix to reach the tip probably reduces the vascularization of organ leading to gangrenous appendicitis and perforation.

Snell quoted as extent of mesoappendix not related to age, height and weight of the individual.

In Rehman study, two – third extension of mesoappendix was 45% and common in pelvic position. The half extension of mesoappendix was 31% and common in retrocaecal position. Whole extension been in 24% and again common in pelvic variety. Two and third extension of mesoappendix was more than half extension and whole extension.

Complete extension of mesoappendix was more than incomplete variety in the study of Geethanjali, Tolfigui, sinha, Ghorbani and kasukorthy.

Incomplete extension dominates in study of Gopalipour, Janardhana rao, Uma Maheswar rao, Ghorbani 2014 the frequency of incomplete mesoappendix

was highest in the age group below 10 years. Incomplete mesoappendix could be one of the reason for security of appendicitis in childhood.

In the present study complete extension of mesoappendix was more than incomplete variety.

Table: 24**NUMBER OF APPENDICULAR ARTERY**

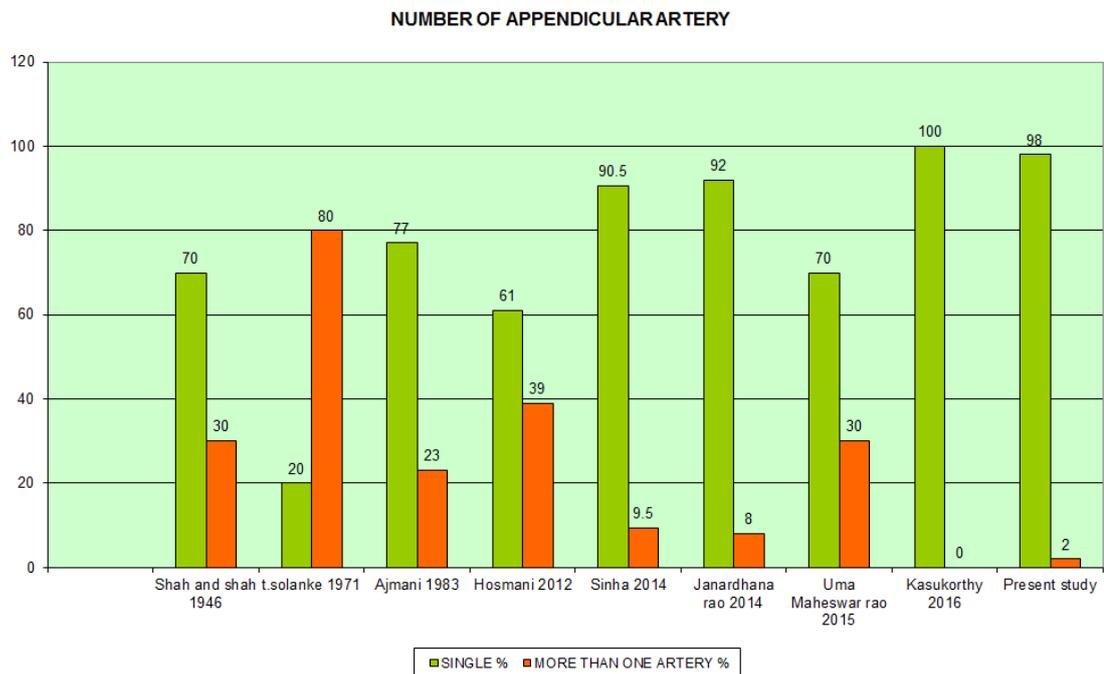
| S.NO | NAME OF AUTHOR | SINGLE | | MORETHAN ONE ARTERY |
|-------------|--------------------------|---------------|----|----------------------------|
| 1 | Shah and shah | 70 | | 30 |
| 2 | T solanke | 20 | | 80 |
| 3 | Ajmani 1983 | 77 | | 23 |
| 4 | Hosmani 2012 | 61 | | 39 |
| 5 | Sinha 2014 | Male | 97 | 3 |
| | | Female | 83 | 17 |
| 6 | Janardhana rao 2014 | 92 | | 8 |
| 7 | Uma Maheswar rao 2015 | 70 | | 30 |
| 8 | Kasukorthy 2016 | 100 | | |
| 9 | Present study | 98 | | 2 |

In 1946, shah and shah studied the blood supply of the appendix in 60 bodies and reported that 70% has single AA and 30% more than one. In Solanke study (1970) the appendix was supplied by more than one AA in 80% of cases.

Hosmani veeresh (2012) studied the arterial supply and reported the origin of AA from inferior division of ilocolic artery in 46.15% and directly from ileocolic artery in 19.23%. Origin AA from arterial arcade in 3.84% and additional appendicular artery in 23% of specimens.

In a study of Arindom Banerjee (2012) in 25 cadavers, in two specimens appendix was found to be supplied by artery of seshalam, from posterior caecal branch at ileo colic artery in addition to AA.

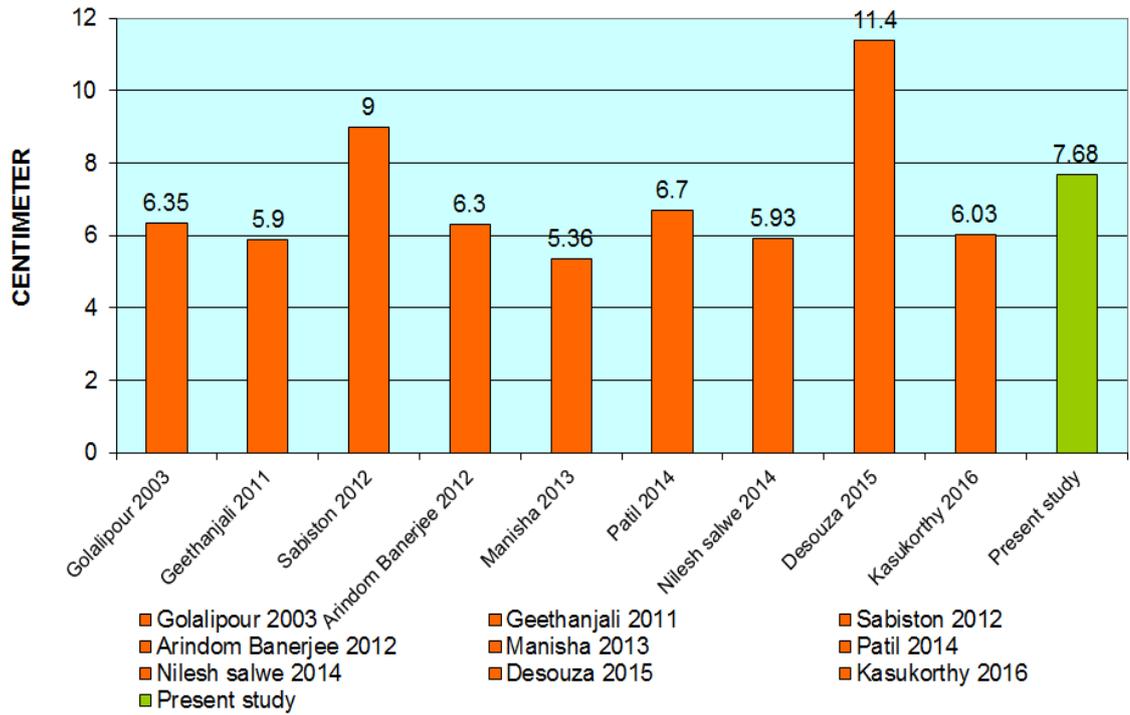
In most of the studies, Sinha (2014) Janardhana rao (2014) Uma Maheswara rao (2014) and Kasukorthy (2016) the single appendicular artery was supplying VA.



In the present study single AA was present in 49 specimens (98%) and one caecal AA in one specimen (2%)

Umesh (2011) Stated that accessory AA provides some immunity against appendicitis. These arteries supply the tip of the appendix, reduce the gangrene formation. Lymphatics travel along the arteries are important in oncological treatment of appendicular tumours.

LENGTH COMPARISON - DIFFERENT STUDY VS PRESENT STUDY



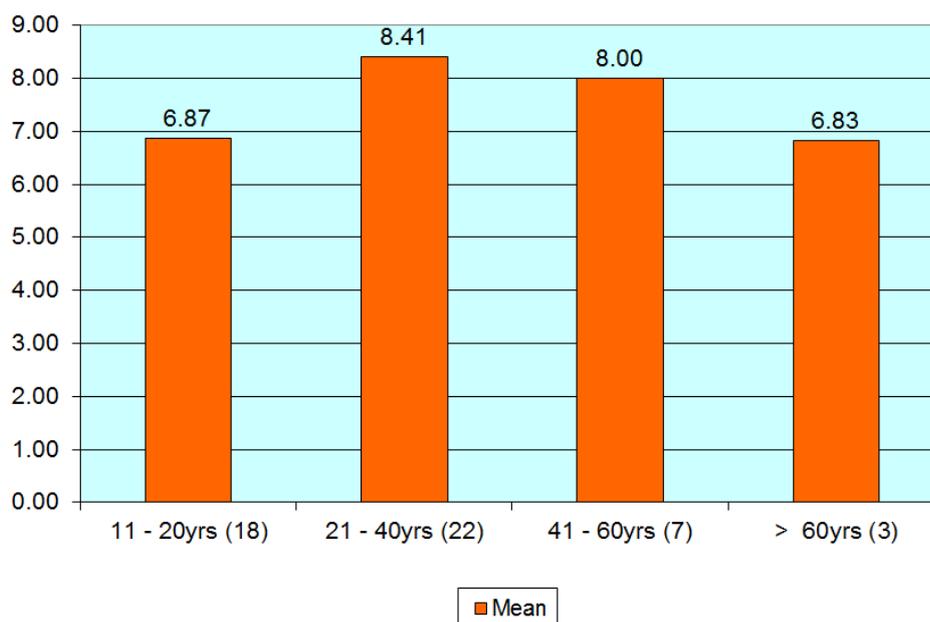
Present study was comparable with other studies

Table: 25

Length of appendix and age comparison

| Age in years | Length of the appendix | | |
|-----------------|------------------------|------|-----------|
| | Mean | SD | p value |
| 11 - 20yrs (18) | 6.87 | 1.37 | 0.049 Sig |
| 21 - 40yrs (22) | 8.41 | 2.13 | |
| 41 - 60yrs (7) | 8.00 | 1.16 | |
| > 60yrs (3) | 6.83 | 1.89 | |

AGE VS LENGTH OF APPENDIX (MEAN)



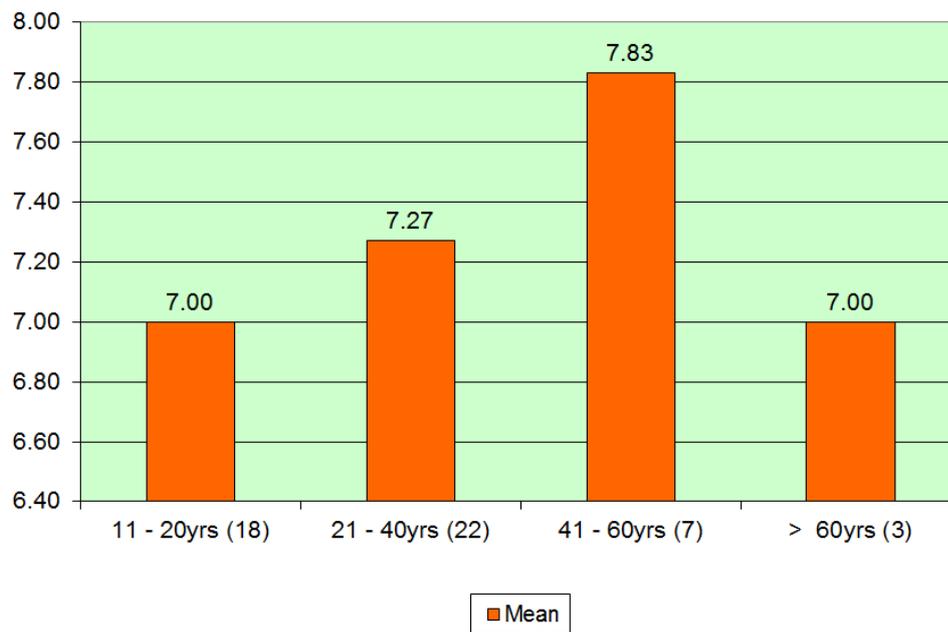
P value of 0.049 is significant in relationship between age and length of the appendix.

Table: 26

External diameter and age comparison

| | external Diameter | | |
|---------------------|--------------------------|------|----------|
| Age in years | Mean | SD | p value |
| 11 - 20yrs (18) | 7.00 | 1.33 | 0.779 NS |
| 21 - 40yrs (22) | 7.27 | 1.55 | |
| 41 - 60yrs (7) | 7.83 | 4.19 | |
| > 60yrs (3) | 7.00 | 1.73 | |

AGE VS EXTERNAL DIAMETER (MEAN)

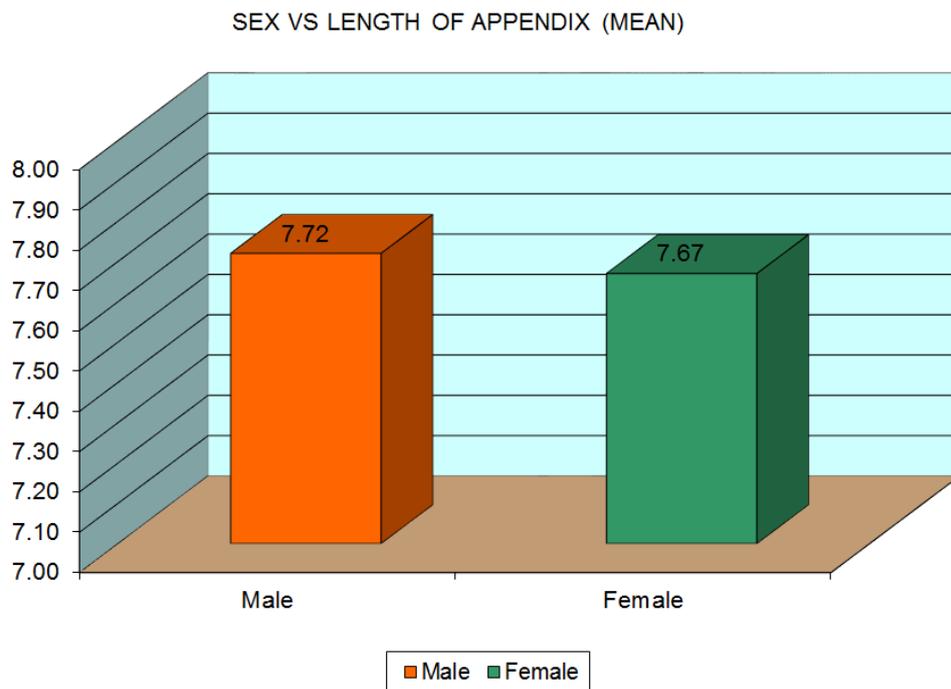


No significant relationship between age and external diameter of appendix.

Table: 27

Length of the appendix and sex comparison

| Sex | Length of the appendix | | |
|--------|------------------------|------|---------|
| | Mean | SD | p value |
| Male | 7.72 | 1.73 | 0.917 |
| Female | 7.67 | 2.09 | NS |

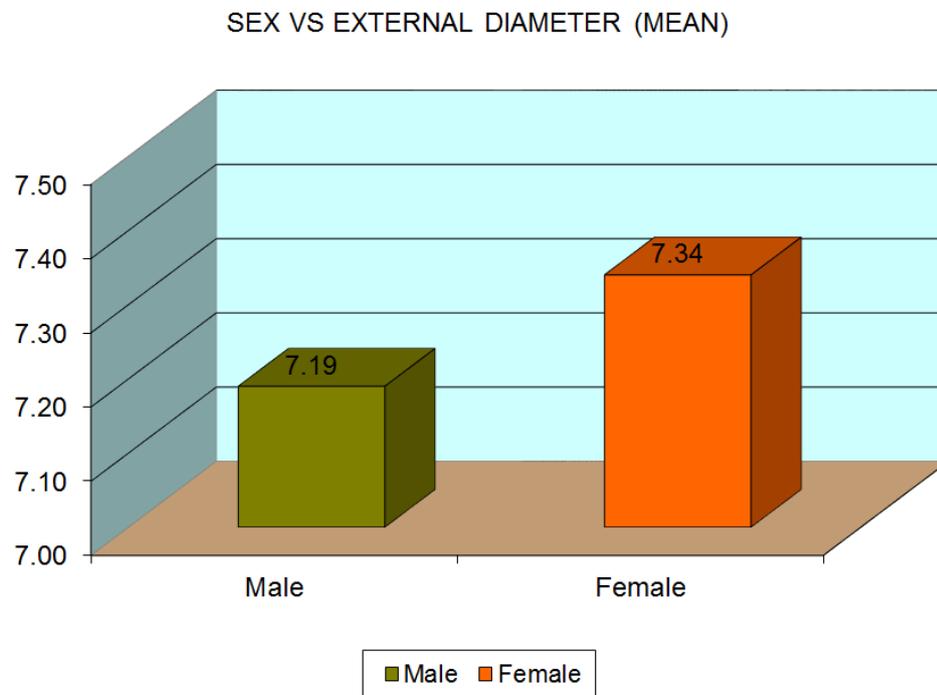


No significant association between Sex and length of the appendix

Table: 28

External diameter and sex comparison

| Sex | External Diameter | | |
|--------|-------------------|------|---------|
| | Mean | SD | p value |
| Male | 7.19 | 1.33 | 0.802 |
| Female | 7.34 | 2.82 | NS |



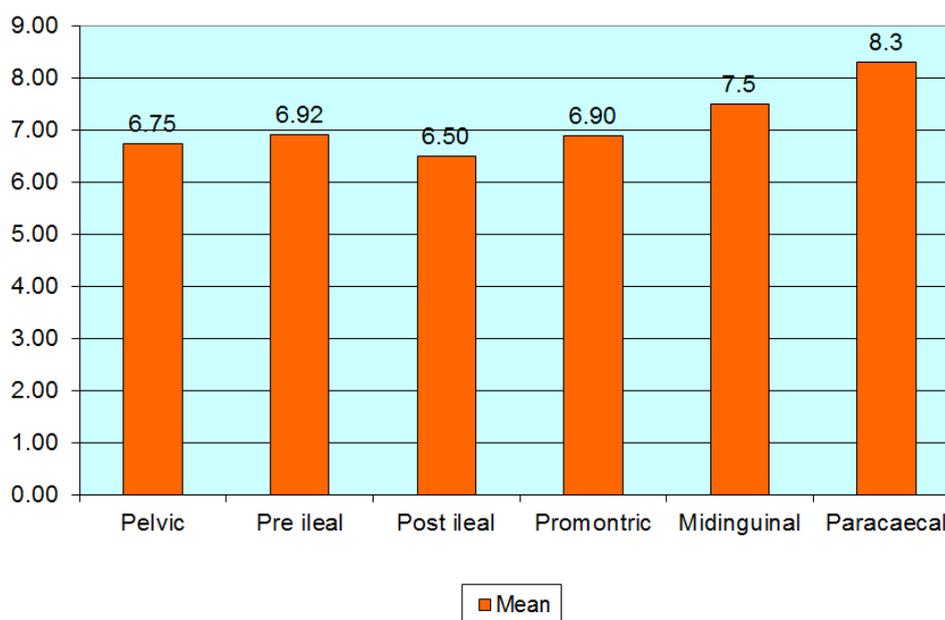
No relationship between Sex and External diameter and p value not significant.

Table: 29

External diameter and position comparison

| Position | External Diameter | | |
|-------------|-------------------|------|----------|
| | Mean | SD | p value |
| Retrocaecal | | | 0.827 NS |
| Pelvic | 6.75 | 2.22 | |
| Pre ileal | 6.92 | 1.62 | |
| Post ileal | 6.50 | 2.12 | |
| Promontric | 6.90 | 1.02 | |
| Midinguinal | 7.5 | 2.41 | |
| Paracaecal | 8.3 | 0.57 | |

POSITION VS EXTERNAL DIAMETER (MEAN)

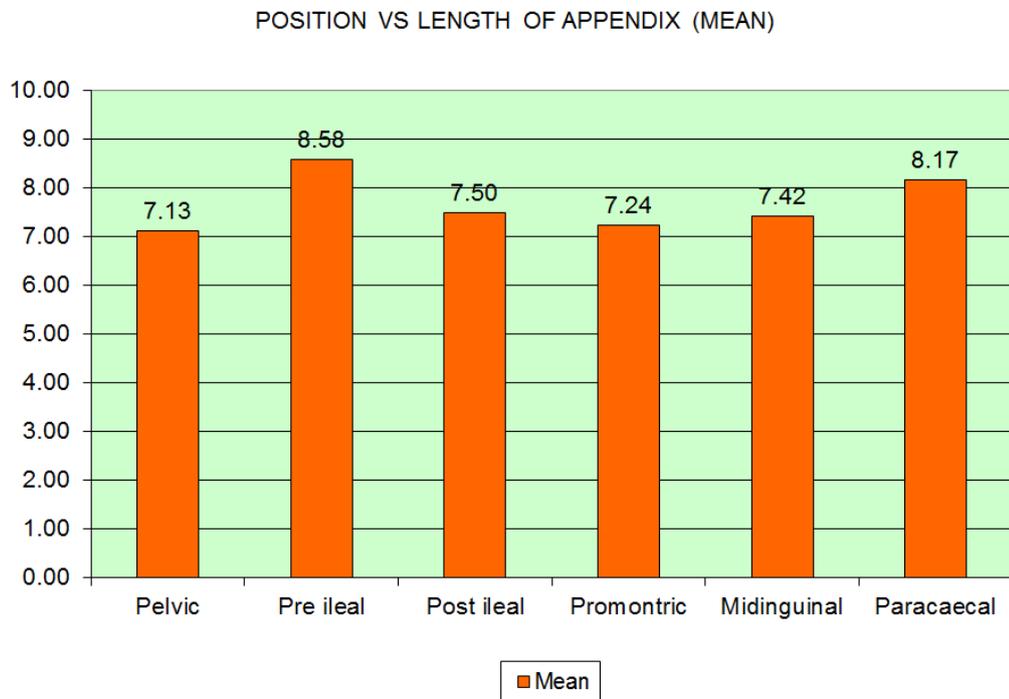


No relationship between sex and external diameter

Table: 30

Position and length of appendix comparison

| Retrocaecal | Mean | SD | p value |
|-------------|-------------|------|----------|
| Pelvic | 7.13 | 2.53 | 0.541 NS |
| Pre ileal | 8.58 | 2.45 | |
| Post ileal | 7.50 | 2.12 | |
| Promontric | 7.24 | 1.29 | |
| Midinguinal | 7.42 | 1.43 | |
| Paracaecal | 8.17 | 2.36 | |



No significant relationship between position and length of the appendix

SUMMARY AND CONCLUSION

SUMMARY

The results of the study of morphology of vermiform appendix were:

- ❖ The age distribution ranged between 13 – 68 years in males and 14 – 52 years in females.
- ❖ There were 31 males and 19 females in the present study.
- ❖ The vermiform appendix located in right iliac fossa in 28 cases (56%) right lumbar region in 6 cases (12%) umbilical region in 4 cases (8%) and inguinal region in 12 cases (24%)
- ❖ The frequency of clock position of vermiform appendix was 14% in 2' o clock position, 24% in 5' o clock position, 6% in 6' o clock position, 14% in 11' o clock position and 42% in 12' o clock position.
- ❖ The direction of tip of the appendix was upwards in 58% downwards in 30% and oblique in 12%.
- ❖ The position of the base of the appendix in posterior caecal wall was 54%, in anterior caecal wall, 8% in lower pole 30% and in lateral wall was 8%
- ❖ The distribution of position of the appendix was retrocaecal 50%, pelvic 12%, pre ileal 5%, postileal 2%, subcaecal, 3% and paracaecal 3%. No subhepatic (or) promontory position was noted.
- ❖ Retrocaecal position was most common in both sexes and postileal was least common in both sexes.

- ❖ The distance between base of the appendix and ileo-caecal valve ranged between 1.5cms – 3.5cms. The average distance was 2.25cm.
- ❖ In the present study 38% at appendix lie along spino umbilical line, 22% lie above SUL and 40% lie below SUL.
- ❖ The average length in males was 7.73cm and females was 7.67cm. The shortest length was 4cm and longest length was 12cm.
- ❖ The length of appendix ranged between 4cms – 7.9cms in 56% at individuals. The maximum length was 12cm present in 4 individuals.
- ❖ The average external diameter in males was 7.45mm and in females was 6.87mm. The external diameter of appendix more than 6mm is clinically significant.
- ❖ The mesoappendix was complete only in 60% and incomplete variety seen in 40%
- ❖ Single appendicular artery was found in 98% at individuals and more than one AA in 2% at individuals. No accessory AA was found.
- ❖ In the present study, one bifid appendix in paracaecal position was found. The length was 8cm and the external diameter was 6mm.

CONCLUSION

- ❖ The vermiform appendix was taken up for study in view of its different positions, changing anatomical relations and the clinical complication when inflamed.
- ❖ Acute appendicitis is still one of the most common reason for emergency admission in hospitals. Life time risk for appendicitis is 8.6% for males and 6.7% for females with increased risk in 2nd decade of life. Appendectomy is one of the most common emergency procedure for the treatment of acute appendicitis. It may be the first surgical procedure for training surgeons. So good knowledge about the various positions, length, external diameter, extent of mesoappendix and its vascular supply is mandatory for interventional surgeons.
- ❖ Knowledge about the length and mean caliber of vermiform appendix will help the surgeons to make use of appendix as an ideal conduit in many reconstructive procedures like Malone antegrade continence enema, appendicoduodenostomy, appendicovesicostomy and creation of trachea-oesophageal fistula.
- ❖ Knowledge about the extent of mesoappendix and vascular variation is also useful in many reconstructive surgeries.
- ❖ Knowledge about duplication of appendix was necessary, otherwise missed second appendix leads to medicolegal consequences.

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ABBREVIATION

| | | |
|------|---|------------------------------------|
| VA | - | Vermiform Appendix |
| MACE | - | Malone Antegrade Continence Enema. |
| MALT | - | Mucosa Associated Lymphatic Tissue |
| AA | - | Appendicular Artery |
| Cm | - | Centi metre |
| Mm | - | Milli metre |
| ICJ | - | Ileo-Caecal Junction |
| SUL | - | Spino Umbilical Line |
| SD | - | Standard Deviation |
| NS | - | Not Significant |

Master Chart

| S.No | Age | Sex | Location of appendix | Clock position | Direction of Tip | Position of base in relation with caecal wall | Position in relation to caecum & ileum | Distance between base and iliocaecal junction | Relation of base to spino umbilical line | Length of the appendix | External Diameter | Extent of Mesoappendix | No of appendicular artery | Anomaly of appendix |
|------|-----|-----|----------------------|----------------|------------------|---|--|---|--|------------------------|-------------------|------------------------|---------------------------|---------------------|
| 1 | 30 | M | RIF | 12 | Up wards | Posterior | Retrocaecal | 2.5cm | Below | 6.5cm | 6mm | Complete | One | |
| 2 | 18 | F | RIF | 12 | Up wards | Posterior | Retrocaecal | 2cm | Below | 7cm | 8mm | In complete | One | |
| 3 | 41 | F | RIF | 12 | Up wards | Posterior | Umbilical | 2cm | Along | 7cm | 12mm | In complete | One | |
| 4 | 36 | F | RIF | 12 | Up wards | Lateral | Retrocaecal | 2.5cm | Below | 6.5cm | 8cm | In complete | One | |
| 5 | 55 | M | R Lumbar | 12 | Up wards | Posterior | Retrocaecal | 1.5cm | Below | 10cm | 6mm | Complete | One | |
| 6 | 56 | M | RIF | 12 | Up wards | Posterior | Paracaecal | 2cm | Below | 7cm | 8mm | Complete | One | |
| 7 | 43 | F | Umbilical | 2 | Oblique | Anterior | Preileal | 1.5cm | Above | 8cm | 6.5mm | Complete | One | |
| 8 | 13 | M | RIF | 2 | Oblique | Posterior | Postileal | 2cm | Along | 9cm | 8mm | Complete | One | |
| 9 | 19 | M | RIF | 12 | Up wards | Lateral | Retrocaecal | 2cm | Along | 6.5cm | 7mm | Complete | One | |
| 10 | 25 | M | Inguinal | 5 | Downwards | Lower Pole | Pelvic | 3cm | Above | 5.5cm | 8mm | In complete | One | |
| 11 | 21 | M | RIF | 5 | Downwards | Lower Pole | Pelvic | 2.5cm | Below | 12cm | 6mm | In complete | One | |
| 12 | 15 | F | R Lumbar | 2 | Up wards | Anterior | Preileal | 2.5cm | Along | 8cm | 6mm | In complete | One | |
| 13 | 24 | F | RIF | 12 | Up wards | Posterior | Retrocaecal | 2cm | Along | 6cm | 6mm | Complete | One | |
| 14 | 63 | M | RIF | 12 | Up wards | Posterior | Retrocaecal | 2cm | Along | 6cm | 5mm | Complete | One | |
| 15 | 21 | F | RIF | 12 | Up wards | Lateral | Paracaecal | 2cm | Below | 10cm | 10mm | In complete | one | |
| 16 | 20 | F | RIF | 12 | Up wards | Posterior | Retrocaecal | 3cm | Above | 6cm | 6mm | Complete | One | |
| 17 | 16 | F | Umbilical | 2 | Oblique | Anterior | Preileal | 2cm | Above | 5cm | 8mm | Complete | One | |
| 18 | 65 | M | Inguinal | 6 | Downwards | Lower | Subcaecal | 3cm | Below | 5.5cm | 8mm | Complete | One | |

| | | | | | | | | | | | | | | |
|----|----|---|-----------|----|-----------|------------|-------------|-------|-------|----------|------|-------------|-----|-------|
| 19 | 27 | M | Inguinal | 5 | Downwards | Posterior | Pelvic | 2cm | Below | 7.5cm | 8mm | Complete | One | |
| 20 | 13 | M | RIF | 12 | Up wards | Posterior | Retrocaecal | 2cm | Along | 5cm | 8mm | Complete | One | |
| 21 | 47 | M | R Lumbar | 2 | Up wards | Posterior | Retrocaecal | 1.5cm | Above | 8cm | 8mm | In complete | One | |
| 22 | 24 | M | RIF | 11 | Up wards | Posterior | Retrocaecal | 1.5cm | Above | 7cm | 6mm | Complete | One | |
| 23 | 49 | M | Inguinal | 5 | Downwards | Lower | Pelvic | 3cm | Below | 9cm | 5mm | In complete | One | |
| 24 | 27 | M | RIF | 12 | Up wards | Lateral | Paracaecal | 3cm | Along | 8cm/ 8cm | 6mm | Complete | two | Bifid |
| 25 | 15 | F | RIF | 11 | Up wards | Lateral | Paracaecal | 2cm | Above | 4cm | 5mm | In complete | One | |
| 26 | 18 | M | Umbilical | 2 | Oblique | Posterior | Postileal | 2cm | Along | 6cm | 5mm | Complete | One | |
| 27 | 29 | M | RIF | 11 | Up wards | Posterior | Retrocaecal | 2cm | Above | 7cm | 10mm | Complete | One | |
| 28 | 13 | M | R Lumbar | 12 | Up wards | Posterior | Retrocaecal | 1.5cm | Along | 8cm | 6mm | In complete | One | |
| 29 | 18 | M | RIF | 12 | Up wards | Posterior | Retrocaecal | 2cm | Above | 8cm | 8mm | Complete | One | |
| 30 | 15 | M | R Lumbar | 11 | Up wards | Posterior | Retrocaecal | 2.5cm | Along | 9cm | 6mm | In complete | one | |
| 31 | 14 | F | RIF | 12 | Up wards | Posterior | Retrocaecal | 3cm | Below | 8cm | 6mm | Complete | One | |
| 32 | 27 | F | Inguinal | 5 | Downwards | Lower pole | Pelvic | 2cm | Below | 7cm | 6mm | In complete | one | |
| 33 | 36 | F | Inguinal | 5 | Downwards | Lower pole | Pelvic | 3cm | Below | 12cm | 5mm | In complete | one | |
| 34 | 17 | M | RIF | 12 | Up wards | Posterior | Retrocaecal | 2cm | Along | 7cm | 7mm | Complete | One | |
| 35 | 21 | M | R Lumbar | 12 | Up wards | Posterior | Retrocaecal | 2cm | Above | 8cm | 6mm | In complete | one | |
| 36 | 32 | M | RIF | 11 | Up wards | Lower pole | Retrocaecal | 2.5cm | Along | 12cm | 8mm | In complete | one | |

| | | | | | | | | | | | | | | |
|----|----|---|-----------|----|-----------|------------|-------------|-------|-------|--------|------|-------------|-----|--|
| 37 | 68 | M | Inguinal | 6 | Downwards | Lower pole | Subcaecal | 2.5cm | Along | 9cm | 8mm | Complete | one | |
| 38 | 29 | F | Inguinal | 5 | Downwards | Lower pole | Pelvic | 2CM | Below | 12cm | 8mm | In complete | one | |
| 39 | 17 | F | RIF | 12 | Up wards | Posterior | Retrocaecal | 2cm | Along | 7cm | 10mm | Complete | One | |
| 40 | 25 | M | RIF | 12 | Up wards | Posterior | Retrocaecal | 2cm | Below | 7.5cm | 8mm | Complete | One | |
| 41 | 13 | M | RIF | 12 | Up wards | Posterior | Retrocaecal | 2.5cm | Along | 7cm | 8mm | In complete | one | |
| 42 | 38 | M | RIF | 11 | Up wards | Posterior | Retrocaecal | 2cm | Below | 7.5cm | 6mm | Complete | One | |
| 43 | 36 | F | Inguinal | 5 | Downwards | Lower pole | Pelvic | 2.5cm | Along | 8cm | 6mm | Complete | One | |
| 44 | 33 | F | Inguinal | 6 | Downwards | Lower | Subcaecal | 3.5cm | Below | 10cm | 9mm | Complete | One | |
| 45 | 22 | M | RIF | 2 | Oblique | Posterior | Preileal | 1.5cm | Along | 8cm | 8mm | In complete | One | |
| 46 | 17 | M | Inguinal | 5 | Downwards | Lower pole | Pelvic | 1.5cm | Along | 6cm | 8mm | Complete | One | |
| 47 | 23 | M | RIF | 5 | Downwards | Lower pole | Pelvic | 2cm | Below | 6.5cm | 10mm | Complete | one | |
| 48 | 52 | F | RIF | 5 | Downwards | Lower pole | Pelvic | 3cm | Below | 7cm | 5mm | Complete | One | |
| 49 | 28 | M | Inguinal | 5 | Downwards | Lower pole | Pelvic | 2cm | Above | 10.5cm | 8mm | In complete | one | |
| 50 | 20 | F | Umbilical | 2 | Oblique | Anterior | Preileal | 2cm | Below | 7.2cm | 6mm | Complete | one | |



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